Cape Peninsula University of Technology

GAMIFICATION AS A TOOL FOR DEVELOPING CRITICAL THINKING AMONG ICT STUDENTS AT A TERTIARY INSTITUTION IN SOUTH AFRICA

by

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DECLARATION

I, Ntombifikile Fortunate Mposula, declare that the contents of this thesis represent my own unaided work, and that the thesis has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the Cape Peninsula University of Technology.

_____ 23 October 2019

Signature **Date**

ABSTRACT

The recent generation of students, often referred to as 'Millennials', are generally familiar with computer games and therefore learn mostly through virtual experiences from game playing. A high failure rate due to the lack of critical thinking (CT) skills among tertiary students still persists, despite the implementation of CT enhancing programmes and frameworks. The aim of this research was to explore the effect of gamification on the critical thinking skills of Information and Communications Technology (ICT) students. A single pre-and post-quasi-experimental research strategy with a pragmatic perspective research approach was followed. Mixed methods research with self-administered semi-structured questionnaires and interviews was employed. In total, 182 questionnaires distributed to students were analysed pre- and post-intervention, and five (5) interviews were conducted with the relevant lecturers post-intervention. The data were summarised and categorised by applying thematic analysis. All participants volunteered to be part of the study, and they were informed of the confidentiality and anonymity of the research before partaking in the study. From the inductive study results, it was found that CT is already an integral part of the subject content being taught to the students. The experimental learning environment did not result in significant domain-general CT compared to the control environment. *Judgement* was the only CT skills element showing a significant improvement from pre- to post-results on the respondents' overall CT. Gamification can be an effectual instrument to enhance CT skills, as it enables the retention of knowledge through play by motivating and stimulating inquisitiveness among students.

Keywords: Gamification, critical thinking, millennials, ICT, game-based learning

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ABBREVIATIONS/GLOSSARY OF TERMS

Acronym / Term	Definition
Critical Thinking (CT)	It is the ability to think clearly and rationally, understanding the logical connection between ideas (Newman, Webb & Cochrane, 2004)
Digital game-based learning (DGBL)	The use of digital or online games for learning (Huang, Huang & Tschopp, 2010)
E-service / Electronic services	Government services lead to easy online accessibility, and this reduces cost of access, streamlines administrative processes, improves turnaround times and strengthens accountability and responsiveness (Nasution, Fauzi & Rini, 2019)
Gamification	Adding game fundamentals to a learning activity (Seaborn & Fels, 2015)
Gamified	An activity that has already been chanced into a game-like activity (Carvalho, Araújo & Zagalo, 2014)
Game-based learning (GBL)	A game play that has defined learning outcomes (Huang, Huang & Tschopp,2010)
Higher Education Institution (HEI)	A level of education provided by ether traditional universities or universities of technology (UoT) that award academic degrees or professional certificates (Gitsaki et al., 2013)
Information and Communications Technology (ICT)	ICT refers to the technologies that provide access to information through telecommunications. This may include the Internet, cell phones, and other communication mediums (Easterbrook, 2014)
Millennials	Also known as Generation Y, refers to people that were born between 1980 and 2000 and reached their adulthood early in the 21st century (Kalinauskas, 2014)
Outcome-based education (OBE)	It is an educational theory that is based on outcomes. Students are encouraged to achieve certain goals at the end of an educational experience (Mouton, Louw & Strydom, 2012)
University of Technology (UoT)	It is an institution of higher education and research, which grants academic degrees in a variety of subjects. The university provides both undergraduate education and postgraduate education (Gitsaki et al., 2013)

CHAPTER ONE: INTRODUCTION, PROBLEM STATEMENT AND OBJECTIVES

1.1 Introduction and background

The rapid transformation in society has a direct evolutionary impact on the South African education system, which moved from content-based to outcome-based, resulting in what is known as Outcome-Based Education (OBE) (Engelbrecht & Harding, 2008; Maddock & Maroun, 2018; Russell, Sirota & Ahmed, 2019). The OBE system assures the following mechanisms: development relevance, accountability, ownership, flexibility in master skills timeframes, and international competitive quality standards. Although OBE had been in effect for more than a decade in South Africa, there are still concerns about the inadequate implementation strategies of the system. Some of these concerns include: i) the shortage of qualified teachers; and ii) teachers who feel unfulfilled and as a result leave the educational sector (Manda, 2014; Russell, Sirota & Ahmed, 2019) .

The Department of Basic Education's (DBE) concern about students in the education system lacking critical thinking (CT) and problem solving skills has led to the introduction of OBE (Engelbrecht, Harding & Phiri, 2010; Russell, Sirota & Ahmed, 2019). OBE has the potential of equipping learners with thinking, life and social skills to prepare them for the workplace, although no clear procedures for the transformation of students to critical thinkers are outlined (Giessen-Hood, 1999).

Moreover, OBE is being perceived as student-centred learning where innovative and flexible teaching and learning emphasises the students' performance (Giessen-Hood, 1999; Maddock & Maroun, 2018). CT supports engagement of the mind, thereby enabling students' problem-solving skills, creativity, and deep thinking. With all the complexities of Information and Communications Technology (ICT) in the South African educational environment, new ways of learning have emerged, including e-learning and blended learning, with gamification being one of these. Gamification has the potential to engage learners in these complex learning environments (Huang, Huang & Tschopp, 2010; Walsh et al., 2019). Games engage and motivate individuals through "play", while also allowing them to learn and master new skills (Tavakkoli, Loffredo & Ward, 2014; Kam & Umar, 2018).

Gamification is a strategy of using game methodologies and instruments in a non-game environment (Kapp, 2012; Sillaots, 2012; Alsawaier, 2018). Gamification could prove to be a technique for teaching and learning for students to develop mathematics and science literacy (Abdullah et al., 2012). Some researchers demonstrated that the use of gamification could improve students' learning

significantly and bring about the mastering of mathematics subjects (Abdullah et al., 2012; Jayasinghe & Dharmaratne, 2013; Faghihi et al., 2014; Bitter & Corral, 2015; Alsawaier, 2018). Gamification is not just a hands-on learning approach; it is also capable of embodying a diverse group of learning theories to address different learning needs.

Gamification incorporates the application of game mechanisms and dynamics into a non-game environment to influence the behaviour and to increase the engagement of gamers (students) for attractive learning and reward achievement (Kiryakova, Angelova & Yordanova, 2014; Rasool et al., 2014; Alsawaier, 2018; Kam & Umar, 2018). Furthermore, gamification might contribute to deep learning opportunities, information retention, and collaborative work, as well as motivate students and improve individuals' problem solving skills (Rasool et al., 2014; Gomes, Figueiredo & Bidarra, 2014). Not only does gamification have a didactic influence, it is also amusing and pleasant, which makes learning fun and engaging, thereby proving to be one of the most favourite activities of the recent generation of students, also known as the Millennials. Gamification does not suggest creating a game, but performing game-like tasks that incorporate the didactic process. Notwithstanding, the impression of some scholars is that careful consideration and planning need to be done before implementing gamification in any process, no matter how remedial it might be to low-performing students (Lawler, 2014; Dichev et al., 2014).

Lopes (2014:568) defines gamification as "educational strategies which are applied within a subject curriculum and thereby stimulating creativity and curiosity in students". Curiosity is an imperative factor in motivation and engagement. It energises the mind to keep on researching and testing until contented with the results. The effect of repeatedly investigating and testing the results increases CT in students, which comes with the reward of acquiring new knowledge and experiences.

The main aim of using gamification to aid teaching and learning is that it allows students to acquire and retain knowledge while being entertained and motivated. In reference to Yurov et al. (2014:171), knowledge "can be attained in different levels of different stages when using gamification techniques". These researchers also place more emphasis on carefully designing gamification techniques to ensure effective implementation that will motivate and engage students in the learning process.

1.2 Background to the problem statement

The cultivation of CT among tertiary students has always been an important outcome. CT supports engaging the minds of students and enhancing the retention of knowledge, particularly for workplace preparation. This has been evident in the results of a survey administered by the Association of American Colleges and Universities (AACU). According to Andreou, Papastavrou and Merkouris (2014), CT is recognised as an envisioned learning outcome for undergraduate students.

There have been a number of views on how this dynamic outcome may be taught and evaluated by researchers (Mulnix, 2012; Kalelioğlu & Gülbahar, 2014; Papathanasiou et al., 2014; Kwan & Wong, 2015; Walsh et al., 2019). According to De-Marcos, García-López and García-Cabot (2017), educational institutions must emphasise CT skills for better industrial results. Amora and Lopez (2017:51) suggest that the infusion of CT into tertiary institutions' curricula be implemented, with testing its efficiency as an integral part of the curriculum. Some of the scholars developed programmes such as 'Critical Thinking Across the Curriculum' (CTAC) and Paul-Elder's CT framework to encourage the acquisition and development of CT skills (Ennis, 2013; Van Loon & Lai, 2014; Walsh et al., 2019). Ennis (2013:25) advocates teaching CT as a first-year separate course by means of CTAC, a programme implemented to ensure that all students across the various disciplines receive the necessary training to help them think critically. A benefit of a programme such as CTAC is that it eliminates the repetition of general CT principles that could occur when implementing separate and different courses. Some researchers use a structured framework that aims at developing certain essential intellectual characteristics in a thinker by applying Universal Intellectual Standards to evaluate the archetypal elements of thought (Van Loon & Lai, 2014:6). The implementation of this framework also ensures the acquisition of problem solving and CT skills enforced by the information literacy standards for Science, Engineering, and Technology (SET). Van Loon and Lai (2014:6) believe that the use of this framework will eliminate concerns related to evaluating CT in engineering courses. Despite the research done on the development of students' CT ability, the lack of CT among students is still a major concern of tertiary institutions (Van Loon & Lai, 2014).

1.3 Problem statement

Despite the implementation of CT standards as well as programmes and frameworks to enhance the CT of students, the lack of critical thinking skills persists, resulting in a high failure rate among tertiary students.

1.4 Research questions

The main research questions (RQs) and sub-research questions (SRQs) for the study are as follows:

RQ1: What are the challenges for ICT educators in teaching students to think critically?

- **SRQ 1.1:** What thinking skills are to be considered for ICT teaching and learning to enhance critical thinking among students?
- **SRQ 1.2:** How can critical thinking be taught to ICT tertiary students?
- **SRQ 1.3:** How can critical thinking be assessed at tertiary institutions?

RQ2: How can gamification contribute towards critical thinking skills?

- **SRQ 2.1:** How can gamification engage the student in critical thinking?
- **SRQ 2.2:** How can students use gamification as a tool to improve their critical thinking skills?

1.5 Research aim

This research aimed to explore the effect of gamification on the critical thinking skills of ICT students.

For this study, CT is described as using the CT skills elements as explained in Figure 1.1:

i. **Problem identification:** The ability to identify a problem and its significance (Landis et al., 2007; Dewanto, Agustianto & Sari, 2018)
ii. **In-depth clarification:** The precise clarity and complexity of a problem (Paul, Elder & Bartell, 1997; Deechai, Sovajassatakul & Petsangsri, 2019)
iii. **Judgement:** The logic and ability to take a decision on the solution of the problem (Mezei, 2015; Zhang & Kim, 2018)
iv. **Inference:** The fairness and consideration of other views or opinions for problem resolution (Bowen, 2017; Zhang & Kim, 2018)
v. **Strategy formation:** The ability to establish a plan for resolution (Rodzalan & Saat, 2015)

These CT elements were used in a student questionnaire to determine the type of CT skills acquired by the target group.

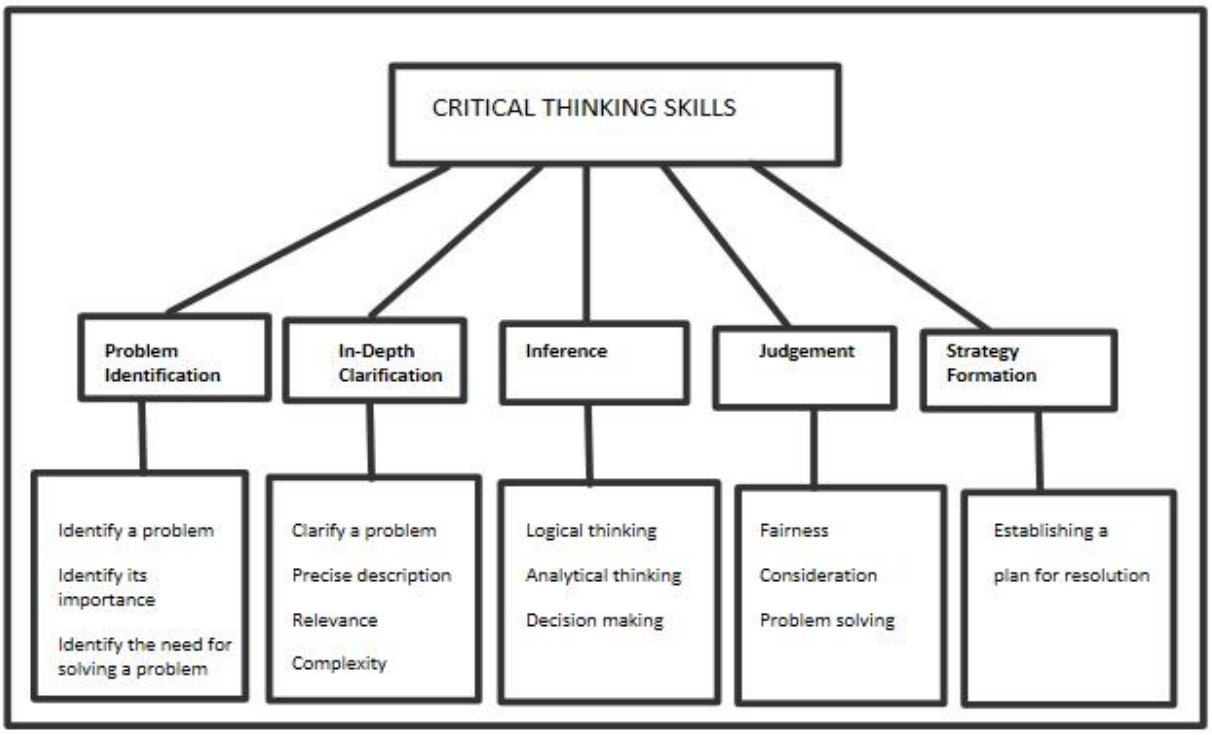

Figure 1.1: Critical thinking skills

1.6 Research objectives

i. To identify an instrument to encourage CT skills
ii. To investigate the use of gamification in ICT subjects for students at Higher Education Institutions (HEIs) to complement their CT skills
iii. To identify the use of gamification in ICT subjects for motivation and enjoyment in studying ICT, and to consequently promote CT skills for undergraduate students
iv. To propose the use of gamification as a tool for CT among ICT undergraduate students

1.7 Research methodology

1.7.1 Research philosophy

A pragmatic perspective research approach was adopted for this study, as the focus was on applied research, and data were interpreted based on the integration of different viewpoints (Saunders, Lewis & Thornhill, 2009).

1.7.1.1 Ontology

The use of games in education has been a new technique employed for teaching and learning based on the benefits highlighted above. According to Saunders, Lewis and Thornhill (2009), ontology studies the nature of being. A pragmatic stance was adopted by the researcher, as it was not realistic to adopt either of the philosophies in practice.

1.7.1.2 Epistemology

Saunders, Lewis and Thornhill (2009) refer to epistemology as established acceptable knowledge to the field of study. Pragmatism was adopted for this study as the researcher used practical concerns when evaluating interpretive knowledge in the use of gamification (Saunders, Lewis & Thornhill, 2009). This allowed for discussions between the researcher and the interviewees, thereby bringing more understanding of how they both interpreted the reality of using gamification.

1.7.2 Research approach

This study embraced mixed methods research (both qualitative and quantitative paradigms) thereby embodying both the inductive and deductive research approach.

1.7.3 Research strategies

Two strategies were followed – the quasi-experimental approach and the case study. According to White and Sabarwal (2014), a quasi-experimental methodology is a strategy that tests the unpremeditated hypothesis and benefits non-random assignments. Quasi-experimental methods are also beneficial when an intervention has been administered for control and experimental groups. This study investigated the development of CT skills between three groups of students, where a casual hypothesis was tested on a non-random selected sample, with similar pre- and post-intervention characteristics.

A further strategy followed is the case study. A case study, according to Zainal (2007), enables the exploration and understanding of complex issues as it is considered the best when mixed methods research is conducted. A tertiary education institution with the focus on the IT department was used as case for this research. Baxter and Jack (2008) state that case studies permit the researcher to respond to questions such as “how?” and “why?” This strategy was essential for the study, as the researcher used two different data sources that required triangulation before release of the results.

Moreover, the study sought to explore a rich understanding of the research questions, and both the explanatory and exploratory components of the study were shown. A single control group and two experimental groups were employed. The study was based on temporary events, where the population was registered for the relevant module (Entrepreneur Skills 1, Information Systems 2, and Business Analysis 3) of the ICT Diploma.

1.7.4 Unit of analysis

The unit of analysis is defined as an entity to be analysed in a research study. According to Baxter and Jack (2008), it is not easy to determine the unit of analysis, especially if a researcher has more than one research question to answer. This study explored the effect of gamification on the CT skills of ICT students, with specific focus on the motivation and confidence of the gamification students as discussed in the introduction (section 1.1). The unit of analysis for this research has been identified as the CT skills of the participating students in the IT department at a tertiary institution. Yin (2008) advocates that defining the unit of analysis procedurally assists researchers in case comparisons.

The units of observation were identified as the participating students and the lecturers responsible for teaching in the IT department.

1.7.5 Sampling

The sampling frame for the population of the study is non-random and purposively selected IT students from the class register list on the University's registration system for the three modules (Business Analysis 3.1, Information Systems 2.2 and Entrepreneur Skills 1.1) relevant to the study.

1.7.6 Data collection

Data collection was done in three stages, using two different techniques. For the first and second stages, self-administered questionnaires were given to students and used to investigate the quantitative paradigm of the study. The third stage was in the form of semi-structured interviews conducted with the lecturers responsible for the students' registered modules relating to the study, and this technique was used to investigate the qualitative paradigm of the study. The benefit of using two different techniques assisted the researcher in using one data collection instrument to corroborate the other. After the pre-data collection, the intervention was applied, where after the post data were collected.

Semi-structured interviews were conducted with the non-random, purposively selected ICT lecturers to explore and understand the level of attention CT skills development receives within the various subjects and year levels of registration. The questionnaires were given to the target group to scrutinise the existence of CT skills in their thinking and to recognise their interests and familiarity with the gaming environment. The students were divided into three different subject groups according to their year level of study to ensure individuality during evaluation.

1.7.7 Data analysis

With understanding the mixed methods research choice assumed by the researcher, data were analysed separately for the different research views, and the results and findings were combined after the analysis as follows: i) quantitative data were analysed using Microsoft Excel 2013; and ii) thematic analysis was done on the qualitative data.

1.7.7.1 Quantitative results

The quantitative (statistic) results were analysed using the contingency table from the Chi-square test. Pre-and post-intervention data were analysed simultaneously, comparing the CT skills results within and between the groups. The gamification intervention had a positive impact on the CT skills for the third year students (section 4.3.6, Table 4.7).

1.7.7.2 Qualitative findings

The qualitative findings from the interviews were done by summarising, categorising, and thematically analysing the data. The following themes were developed from the findings: i) new knowledge base and teaching skills; ii) subject-based curriculum; and iii) assessment rules. The findings revealed that although students entering tertiary education do possess a certain level of CT skills, further CT skills need to be taught and assessed effectively through deep thinking activities done during the teaching and learning process to enable logical thinking, analytical thinking, and problem solving (section 4.5, Table 4.9).

1.8 Headline findings

Gamification is a proven technology innovation that has a positive effect on the CT skills of ICT students. Although CT skills are reportedly integrated into the modules taught to the students, these skills need to be evaluated to ensure the retention of knowledge. The headline findings for the study are summarised in section 4.6, Table 4.12.

1.9 Conclusion

This chapter serves as an introduction to the study. The research is an explanatory mixed methods study, seeking to investigate the effect of gamification on the CT skills of ICT students. The research was done with students registered across different year levels of the ICT Diploma. A quantitative experiment (pre-and post-test) was administered to the participating students to evaluate and measure their CT skills levels, thereby determining the impact of the intervention on the experimental

group before the post-test. The qualitative study was done with the interviewees (lecturers) involved in teaching the students across all the levels of study.

1.10 Ethics

1.10.1 Autonomy

- **Informed consent in assessments and provision of additional information:** All participants volunteered to be part of the study and were briefly informed of the purpose of the study, the knowledge of the assessments forming part of the study, the results, and the research implications (Hejase & Tabch, 2012)
- **Participant disclosure of personal information:** The confidentiality and anonymity of the research before partaking in the study was discussed with the participants. They were also informed of the purpose of the study, and their voluntary participation (Hejase & Tabch, 2012)

1.10.2 Beneficence and non-malfeasance

Students were encouraged to continue participating in other game plays (outside the scope of the study), as the habit of game play boosts the confidence in one's character. Gamification further serves as motivation for students to study and become involved in teamwork. Students were also encouraged not to memorise content that limits a deeper understanding of the content, i.e. surface reading was discouraged.

1.10.3 Justice

The participants were fairly selected according to their class list, from all participating modules of different year levels across the ICT Diploma. They were evaluated equally in accordance with benefits and risks that were experienced by all participants.

1.11 Research scope and limitations

The scope of this research was limited to three different modules on different year levels of the ICT Diploma in the IT department at a delivery site of a UoT in Gauteng. The focus of the study was to enhance the CT skills of IT students by using an intervention in the form of gamification. Although quantitative techniques were included in the research, the sampling and sample size are too small to generalise the results. Other thinking skills and gamification uses might be briefly mentioned or discussed, but they remain outside the scope of this study.

1.12 Summary

Fast evolving technology brings about a serious change in education as well as in the students that have to be taught. This change calls for innovative philosophies in teaching and learning. Formal education does not have to be dull and boring to be effective, hence the introduction of playful learning (learning through play) through game-based learning and now, gamification. Gamification enables motivation, enthusiasm, and liveliness as an educative factor in teaching and learning. Thinking is an everyday exercise, while CT is a necessary characteristic required for analysis and decision making, hence the need to teach and evaluate CT skills.

The researcher followed a cross-sectional quasi-mixed methods design for the study, whereby different study levels of the target groups were used in a conveniently selected, non-random sampling study. A pragmatic research philosophy stance was employed, including both the deductive and inductive research approaches due the nature of the design being both qualitative and quantitative.

This chapter discussed the background to the study of CT skills and gamification environments, as well as the purpose and significance of the study.

1.13 Outline of the study

Chapter One: Introduction, problem statement and objectives

This chapter provides a brief introduction of the OBE education system, the need for CT for students in tertiary education, and the significance of mathematics and science as tertiary prerequisites for the ICT curriculum as well as the use in gamification and learning. A brief investigation into how gamification techniques are applied in tertiary institutions is done. The objectives and possible outcomes of the study are also discussed.

Chapter Two: Literature study

The existing literature on the topic is discussed in this chapter. The historical background, development, and subsequent popularisation of gamification are elaborated on.

Chapter Three: Research methodology

In Chapter Three, the research methods for the study are discussed. The data collection and analysis methods are presented, discussed, and justified in terms of obtaining information that is complete, relevant, and meaningful.

Chapter Four: Data analysis

Chapter Four involves the analysis of the data gathered in the experimental process and interviews. The researcher organised and grouped the data that were collected with the aim of identifying and grouping common factors, thereby obtaining the required results to fulfil the research objectives of the study.

Chapter Five: Discussion

The analysed results from the quantitative data, the findings from the interviews conducted as well as the themes developed during the analysis are discussed. The combined results and findings from the qualitative and quantitative studies are integrated and elaborated on.

Chapter Six: Conclusion and recommendations

Conclusions and findings are presented in this chapter. The viability of using gamification in the teaching and learning process is compared to that of established normal textbook usage, and conclusions are drawn on whether the use of gamification have an effect on the CT ability in the learning process and increased academic performance of students in tertiary institutions.

In the next chapter, the literature behind the two most supplementing and inspiring concepts (critical thinking skills and gamification) of this research is discussed.

CHAPTER TWO: LITERATURE STUDY

Progress, relevance, and innovation are the mandate for all higher learning institutes, and especially Universities of Technology (UoTs). These dynamics are prompting constant and agile transformation, which is fundamental to every shift in vision or strategy. South Africa is a fast growing and the wealthiest country on the African continent, where pertinent technology is essential to meet the needs of a technologically hungry generation. Many tertiary students lack critical thinking (CT). It seems that the curricula of many UoTs do not focus on CT although in some courses there is an unintended inclusion of developing CT. The aim of this study was to explore the effect of gamification on the critical thinking skills of ICT students. The literature review was done using keywords identified from the title, problem statement, research questions, and aim of the study. These keywords were used to search the CPUT online library databases including Google Scholar, Emerald, Scopus, ProQuest, and EBSCOhost.

The literature review is presented as follows: Introduction, critical thinking, games, gamification, and summary.

2.1 Introduction

South African education has since the introduction of Curriculum 2005, also known as Outcome-Based Education (OBE), changed to become learner-centred. The ineffective deployment of this new curriculum brought about challenges to most learners entering university, as they struggle with reading and understanding content at a reasonable level expected from university students (Engelbrecht, Harding & Phiri, 2010). The intention for implementing a new curriculum was to enhance the learners' CT skills, which, according to Mouton, Louw and Strydom (2012), is ludicrous to expose learners to, especially without considering adequate and accurate information.

The first section of this research focuses on the unpreparedness of South African learners for tertiary education based on the acknowledgement that secondary school leavers are to be mathematics and science literate. Most tertiary institutions are facing the problem of post-matric learners not being ready for tertiary education (Dos Reis, Venter, & McGhie, 2019). The most significant division lies in whether the learners have been properly equipped at their various secondary schools, or whether the education system itself is failing the country (Mouton, Louw & Strydom,

2012). A study on the 2009 intake of students at a university in South Africa shows a gap between the skills required at university level and the actual skills that the post-matric students possess. This has led to radical approaches being implemented at universities in order to ensure effective learning (Engelbrecht, Harding & Phiri, 2010, Dos Reis, Venter, & McGhie, 2019). The current generation of students, known as the "Millennials" and the "Z-generation" learn better with technology (Laura & Penley, 2014). These students are continually surrounded by computers, television, and electronic games, yielding an advantage for e-learning environments (Violante & Vezzetti, 2013; Laura & Penley, 2014). In fact, according to some scholars, the students expect media techniques to be incorporated into their teaching and learning processes (Violante & Vezzetti, 2013). Violante and Vezzetti (2013) deliberated on the influence of a web-based interactive learning application created to teach biomedical engineering students to use an electroencephalogram device. The study has been one of the most successful electronic service (e-service) developments for both educational and industrial purposes, as it permits flexibility and convenience. The integration of ICT into education has brought about benefits such as the ease of access to material in online and virtual learning, up to date solutions, and social network engagements with relevant forums (Pratt, 2013).

2.2 Critical thinking

2.2.1 A brief history of CT

From the time that Socrates first mentioned CT as a concept (2500 years ago) many philosophers, including Plato, caught on to it (Paul, Elder, & Bartell, 1997). The Socrates emphasized the purpose of CT as "the need in thinking for clarity and logical consistency", which would reflectively question the common beliefs and explanations (Paul, Elder, & Bartell, 1997:1). Ennis (1996) personifies the concept and initiates testing through CT. During the 15th and 16th Century, a number of CT scholars such as Francis Bacon joined in exploring the advancement of learning, and during the 17th and 18th Century, scientists such as Sir Isaac Newton carried on with this work. The 19th Century brought the likes of Karl Marx, a social and economic critique, with William Graham Sumner in the 20th Century focusing on sociology and anthropology (Paul, Elder & Bartell, 1997). These philosophers and other critical thinkers paved the way for scientists such as John Dewey, Ludwig Wittgenstein, and Piaget, who, through their research, shed light on contributing to CT development towards the learning processes through:

- The sense of the pragmatic basis of human thought
- Awareness of the egocentric and socio-centric tendencies of human thought

- the point of view or frame of reference within which reasoning takes place (Paul, Elder & Bartell, 1997)
- The need to analyse concepts and assess the power and limitations of these concepts (Paul, Elder & Bartell, 1997)

2.2.2 CT defined

CT has been defined by various philosophers in various disciplines, however there is no universally-accepted definition for CT amongst the involved philosophers. Tang (2016:19) highlights the diversity used by the different researchers to theorize the diverse ways of defining CT as follows:

- They define CT by decoding its process
- Some choose to define CT from the logical and cognitive thinking process point of view
- Some define CT from the philosophical belief of the truth and inference

Paul and Elder (2008a:2) define CT as "the art of analysing and evaluating self-directed, self-disciplined, self-corrected and self-monitored thinking in order to improve it". Behar-Horenstein and Niu (2011:26) outline CT as "an attitude a logical application of skills in problem-solving while describing it a precise assessment of declarations and a construction of a logical and product centred phenomena". Pieterse (2012:6) defines CT as "a higher order thinking, involving reasonable, reflective, responsible, and skilful thinking that is focused on deciding what to believe or do", and "a purposeful thinking, utilising self-regulatory judgement, resulting in interpretation, analysis, evaluation, and inference whilst considering the context of the situation". In collaboration to the similar reflection Qablan, Sahin, and Hashim (2019:21), define CT as "a higher order thinking, which means evaluating the arguments, and the ability to self-organize in order to do the skills of assessment, analysis and conclusion". The authors further explain that CT is not man inherent rather has to be learned, practiced and trained for high degree competence. Similarly, Papathanasiou et al. (2014:283) define CT as "an active mental process and a delicate intuition, synthesis, analysis and evaluation of information collected or received from observation, reasoning, experience or communication which leads to action based on conviction". Critical thinking is CT is defined as "clear and rational thinking which involves critique by making logical judgement" (Tang, 2016:19).

Aljaafi and Sahin (2019) refer to CT as a way of formulating a judgement about the information analysed on ideas from a person's prerequiste information, which aims to preserve and unbiased perspective about the ideas. Similarly, Saputra,

Joyoatmojo, Wardani, and Sangka (2019), mention CT as including expert judgement and a necessary skill, that has to be mastered by everyone in todays work place.

Some definitions of CT are based on the work of Lai (2011:6) that emerged from the philosophical tradition and include:

- "Reflective and reasonable thinking that is focused on deciding what to believe or do
- Skilful responsible thinking that facilitates good judgement
- Judging in a reflective way what to do or what to believe
- Disciplined, self-directed thinking that exemplifies the perfections of thinking appropriate to a particular mode or domain of thought".

According to Khriyenko (2018:6), "CT requires a person to apply various intellectual tools to deliberately and systematically process diverse information so that (s)he can make better decisions and generally understand things better". Furthermore, the author identifies the 'evaluation of evidence' as an essential principle of CT, which is the actual fact-checking technique and probably the most difficult task to identify.

However, this study will assume the definition of critical thinking used by Tang (2016), namely the integration of reflective and independent thinking, which allows one to reflect on the justification and relevance of views and principles.

2.2.3 The role of CT

Developing CT skills amongst undergraduate students is an important and a necessary life skills because it is essential in the workplace. CT plays an imperative part in some occupations, for example, the nursing profession. Papathanasiou et al. (2014:363) explain the role of CT skills as "an essential process for the safe, efficient and skilful nursing practice". The authors further discuss some of the skills developed by CT as critical analysis, problem solving and decision making, since these are important and required as cognitive and analysis skills. Furthermore, Papathanasiou et al. (2014) perceive CT skills as a behaviour-enhancing instrument, as it alters independent thinking, impartiality, perseverance, integrity, spiritual courage, confidence in justification, and humbleness.

CT skills are also considered an important element in the engineering education. Mohamad et al. (2018) explain the role of CT skills in the engineering field as an important skill that leads engineers to become better problem solvers and decision makers. These scholars explain the role of CT as denoting the "capacity to examine

information, to define significance of information collected and interpret that information in problem solving and decision making" Mohamad et al. (2018:487). Moreover, the authors perceive CT skills as "interaction between natural ability and information process by which something novel and valuable is produced" Mohamad et al. (2018:487).

Zhang and Kim (2018:1) perceive CT skills as "one of the essential thinking skills that enables people to improve themselves in the ability of criticising, questioning, evaluating and reflecting". These scholars comment on the necessity of CT skills, as it encourages rational judgement and discernment of the elements of reasoning compared to simple or surface thinking. CT skills are necessary to be cultivates in this digital age, which is exploding with information in order to build responsible citizens that are equipped with informed decision-making and real-world problem solving that enable them to solve problems in their leaning, work, and daily lives (Zhang & Kim, 2018).

Blooms Taxonomy of Cognitive Domain (Bloom, 1956) is a renowned hierarchical model that is still considered an essential model used to categorise the complexity and specificity of educational learning objectives. This model originated in the 1950s from an intention to classify three domains: cognitive, affective and psychomotor, which are belief-based (Dilley, Kaufman, Kennedy & Plunker, 2015).

In 2002, the Taxonomy has been revised and divided into knowledge and cognitive process dimensions. This brought about further discussions and dissections, which led to a number of definitions (Kong, 2014; Yavelberg, 2015; Cottenie & Staempfli, 2016) and characterisations by many CT scholars (Klimova, 2013; Kong, 2014; Reed, 2014; Nkhoma et al., 2016). The theories evolved over time, moving way past the times of John Dewey who described CT as "simple self-reflective to complex, multifaceted definitions and models of cognition" (Dilley et al., 2015:1).

2.2.4 CT skills

CT skills are important in our society, not just for teaching and learning, as CT enhances the identification of problems and systematic problem solving skills, even for employees who are no longer students. Paul and Elder (2008a) advocate CT as foundational to all teaching concepts and subjects, as it enforces effective teaching and learning through providing a set of rich concepts to enable thinking on a higher level.

Mahammoda and Sahin (2019:9) identify CT abilities as recognising the problem, gathering and arranging appropriate information by observing logical connections

between ideas, acknowledging unstated values, comprehending, interpreting and appraising evidence and statements in an accurate and a distinct language, through drawing warranted conclusion constructing ones belief based on the new knowledge rendition and accurate judgement about things and qualities of daily life; in order to find a feasible implementation to solve the problem.

CT skills are an imperative and compulsory attribute for teaching and learning, allowing the student to identify and evaluate ideas, understand the logical connections between ideas, and solve problems systematically (Daniels, 1999). Creativity is another constituent of CT, also considered to be among the highest levels of learning, according to Dewanto, Agustianto and Sari (2018:1). Creative Learning sprouts from the invention of images in the mind, known as imagination, and can be incorporated as one of the features of good and purposeful thinking skills (Lai, 2011).

Lai (2011) identify the CT dispositions as being a component and relevant for CT skills, the author describes the CT dispositions as the attitudes or habits of the mind.the following are the example of CT dispositions identified by Lai (2011:10)

- “open-mindedness (Bailin et al., 1999; Ennis, 1985; Facione 1990, 2000; Halpern, 1998)
- fair-mindedness (Bailin et al., 1999; Facione, 1990)
- the propensity to seek reason (Bailin et al., 1999; Ennis, 1985; Paul, 1992)
- inquisitiveness (Bailin et al., 1999; Facione, 1990, 2000)
- the desire to be well-informed (Ennis, 1985; Facione, 1990)
- flexibility (Facione, 1990; Halpern, 1998)and
- respect for, and willingness to entertain, others’ viewpoints (Bailin et al., 1999; Facione, 1990)”

The same concept of CT dispositions I also discussed in the recent study by Taghinezhad, Riasati, and Behjat (2019:41). Both researchers concur that although CT skills involves disposition,and are relevant components of CT, as mentioned above. CT skills and the CT dispositions are definitely separate concepts.These researchers further highlight that, although a number of philosophers identify the different CT disposition examples, they in fact overlap in nature. Hence, the teaching of CT skills does not only beneit the development of CT but also enhances the CT dispositions.

Scholars agree that CT can be taught; educators therefore need to incorporate salient educational examples that will model CT during teaching and learning (Lai, 2011). CT skills are vital to most professions, and CT is perceived as a life skill, especially for healthcare workers. The number of studies conducted on health and medical care is therefore enormous (Baghcheghi, Koohestani, & Rezaei, 2011; Pucer, Trobec & Žvanut, 2014; Papathanasiou et al., 2014; Kantar, 2014; Andreou, Papastavrou & Merkouris, 2014; Carter, Creedy & Sidebotham, 2015, 2016; Pitt et al, 2015; Weber & Farrell, 2016; Mohamad et al., 2018; Zhang & Kim, 2018).

As mentioned earlier, CT skills are mostly treasured in the health profession. These skills are perceived as an instrument of competency when health care workers performing their duties in terms of integrating technology, science and pathology, and keeping up with scientific knowledge expansion (Pieterse (2012:23).

2.2.5 Teaching and assessing CT

CT is perceived to be transitive; therefore, cognitive education is the most pertinent domain. A taxonomy fashioned by a group of philosophers illustrates a hierarchy that increases in the concreteness and complexity classification of CT skills. This includes knowledge, comprehension, application, synthesis, and evaluation. This model is said to have been long back popular within educators (Dilley et al., 2015).

Paul and Elder (2019:7) suggest a definition which they view as the “the most useful for assessing CT skills”, as previously discussed that CT skills can be defined in various ways, as “a process of analyzing and assessing thinking with a view to improving it. Critical thinking presupposes knowledge of the most basic structures in thinking (the elements of thought) and the most basic intellectual standards for thinking (universal intellectual standards). The key to the creative side of critical thinking (the actual improving of thought) is in restructuring thinking as a result of analyzing and effectively assessing it.”

Klimova (2013:509) recommends that CT skills should be intentionally taught or developed as early as the primary phases of education. The author explains how communism has been threatened by CT. The author also mentions how much impact this regime has on people’s minds as they have been taught to memorise facts and not to think critically. Klimova (2013) further elaborates on the two creative thinking skills phases that are imparted during teaching and learning. The first phase is called **internalisation** and is the construction of basic concepts inherent to the content in the minds of learners. The second phase is **a process of application**, explained as the actual use of concepts, principles, and theories taught. The theorist

contemplates the affluence exploited in the development of thinking skills as it is like a liberating force in education, a powerful resource in one's civil life, and it encourages lifelong learning (Klimova, 2013:509).

The advancement and assessment of CT skills is an imperative implementation and therefore more attention should be given to this, as a lack of CT results in a lack of argumentative skills to perform in universities and the workplace. According to Davies (2013:2), there is an urgent need for CT skills as it is also a complaint from the employers of the students who oblige educators to do something about it. Zhang and Kim (2018:4) emphasise that during the development process of CT skills, seamless, on-going assessment should be integrated for reliable results.

Although philosophers like Klimova (2013) and Richardson and Ice (2010) agree that CT skills can be taught or developed, some of them criticise the fact that they can be measured or evaluated effectively. According to Richardson and Ice (2010:53), numerous assessment measures for CT should be employed on every occasion possible since it is perceived as a multifaceted set of general and specific factors and not a mere general thinking ability. Correspondingly, Hyytinen, Nissinen et al. (2015) investigated the practicality and scientific feasibility of assessing students' knowledge and skills in higher education upon graduation in and across various contexts. This study led to the interpretation that a comprehensive picture of students' CT can possibly be obtained by combining various assessment and analysis approaches.

Willingham (2019:3), firstly highlights the disputation about the different views from philosophers on how CT skills can be taught, which can be through a generic content independent skill or through a content-based skill; and then the author concludes that the philosophers are united in the belief that content knowledge is crucial for effective development of CT. The author further recommends a four step process to develop a program to teach CT as: (1) identify a list of critical thinking skills for each subject domain; (2) identify subject matter content for each domain; (3) plan the sequence in which knowledge and skills should be taught; (4) plan which knowledge and skills should be revisited across years.

Furthermore, the work done by Kalelioğlu and Gülbahar (2014) has been used to identify interaction patterns that promote CT. Their study concludes with a viewpoint that interactions are in fact stimulated by more discussions and CT, which is fostered by using different instructional techniques that should make students think

distinctly for every discussion process. This then prompts educators to cultivate the development of CT skills for the assessment to exist.

Carter, Creedy and Sidebotham (2015) conducted a study on the use of the famed CT Scale (CTS) that assesses CT through inference, assumption recognition and deduction, interpretation, and argument evaluation. The findings conclude that although an initial increase in CT was found in the target group, CT has decreased over time, suggesting that the teaching methodologies were not effective; but, it may also indicate that the CTS is not reliable in measuring CT changes over time. This implicates that facilitators should not rely only on either their instructional methodologies or the assessment tool, but that using a combination of various methods and tools could indicate dependable results.

Standardised CT skills have been used over time and are perceived to be reliable and accurate. Some scholars still use non-standardised tests, which could produce unbalanced results (Carter, Creedy & Sidebotham, 2015). Behar-Horenstein and Niu (2011) point to a case where non-standardised tests were used and acceptable results reported, but the authors could not establish the validity of the study measurement.

Rear (2019:665) explored a number of standardised test currently available for use to teach and evaluate CT skills, the following tests are based on the taxonomy which includes skills such as identifying and analysing a problem, drawing concise, inductive and inferred conclusions and judging the credibility of a source. However, the author, furthermore identifies the following three major drawbacks of standardised CT tests:

i. CT dispositions

   Since CT skills and CT disposition are diffrent concepts they may need diffrent test for evaluation, although as discussed previously; the same philosophy may benefit both concepts.

ii. Domain specificity and transferability

   Standardised CT test cannot apply the candidate's specialised knowledge, they have to be generic. They are therefore, nontransferable from one domain to another.

iii. CT sub-skills

   CT skills are compounded skills, therefore can be broken down into small, discreet and measurable sub-skills or elements (Fig. 1.1,p5).

However, a recent systematic review study on done by Lorencova, Jarosova, Avgitidou, and Dimitriadou, (2019) show that the majority of non-standardised CT

skills test developed by the different researchers in their fields of study, reported a more significant improvemnt of CT skills amongst the participants than the standardised CT tests crafted by the familiar philosophers in CT.

2.2.6 CT models

Duron, Limbach and Waugh (2006) have created a 5-step CT model (Figure 2.1) that can be implemented in any classroom or training setting to help students gain CT skills. They believe that the implementation of this framework in any classroom environment encourages an active, student-centred learning approach to teaching and learning. Measurement

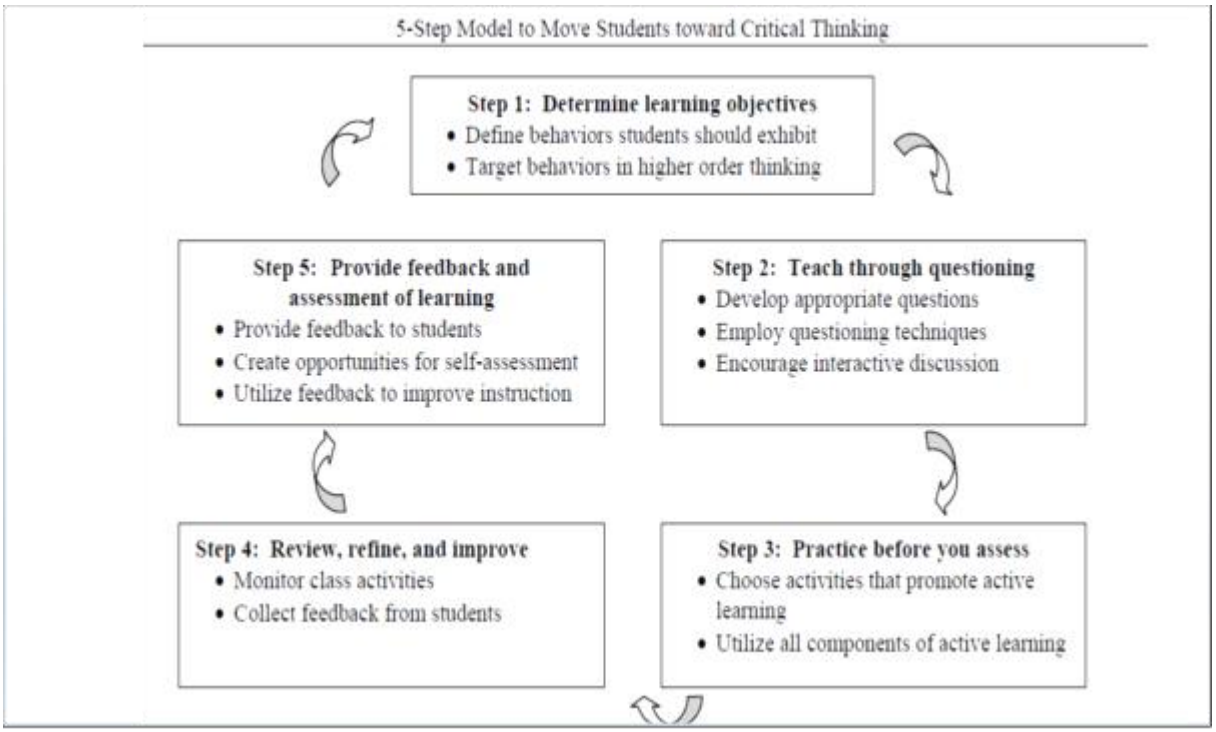

Figure 2.1: Five-step model to move students toward CT (Duron, Limbach & Waugh, 2006:161)

This study is based on the research of Duron, Limbach & Waugh (2006:161) for teachers and educators who are not sure how to teach or assess CT skills. This 5-step framework is offered as a possible solution to assist teachers. The framework is divided into the following sections:

i) Step 1: Determining learning objectives

Step 1 involves the important consideration of the learning programme, its alignment to the learner's studies, and the roles of both the facilitator and the student. It also includes understanding the prerequisites, outcomes, and objectives necessary at the end of the module.

ii) Step 2: Teach through questioning

Questioning is the vital component of teaching to be considered when planning for a lesson to facilitate. This also promotes the facilitator to be well prepared, as all questions should be compiled in order to stimulate interaction and participation.

iii) Step 3: Practice before you assess

The facilitators should be effective participants in the teaching and learning process; in this regard be able to determine the relevant active learning strategies applicable to the learning objectives at that moment.

iv) Step 4: Review, refine and improve

Facilitators always need to strive refining and improving their instructional skills, with the goal to enhance the CT of the students.

v) Step 5: Provide feedback and assessment of learning

Feedback is the most important part of teaching, as its purpose is to improve the quality of the students' learning and performance rather than grading their performance.

The following **benefits** are observed through practising the model (Figure 2.1):

i. Engagement: students tend to do more than simply listening
ii. Problem solving: students are involved in dialogs, debates, and creative writing
iii. Higher-order thinking, synthesis and analytical thinking
iv. Enjoyment: learning experiences are mutually pleasant to the learners and teachers involved

In another CT model investigation, Nilson (2010:9) indicates the levels or stages of cognitive development. The author contrasts Perry's (1985) stages of undergraduate cognitive development and Baxter's Magolda (1992) level of knowledge. The stages were categorised into the following:

i. **Duality**, where student thinking is in black and white, meaning they decide what to believe and how to act based on certain authoritative standards. This is the *absolute knowing* level.
ii. **Multiplicity**, which is the realisation that the authorised standards of thinking are not equal. This *transitional knowing* level refers to the ability to distinguish (stronger and weak authority) and compare the authority believed to be governing the truth.

iii. **Relativism**, which relates to the stage where the student realises the options may be equal and that only a temporary state may assist in the resolution. This is the *independent knowing* level.

iv. **Commitment**, which is the stage where the students commit to a strategic decision, although they may have to frequent the previous stage for assurance; they are now confident with their choices. This is the *conceptual knowing* level Nilson (2010:9).

Gharib et al. (2016:275) propose the framework of promoting CT in e-learning where the participants receive virtual education (Figure 2.2). In this framework, the instructional design and the education management are the main themes, which can be manipulated to improve CT using virtual education. During the virtual study, the belief system is kept constant and is seen a static factor that has no influence on teaching and learning.

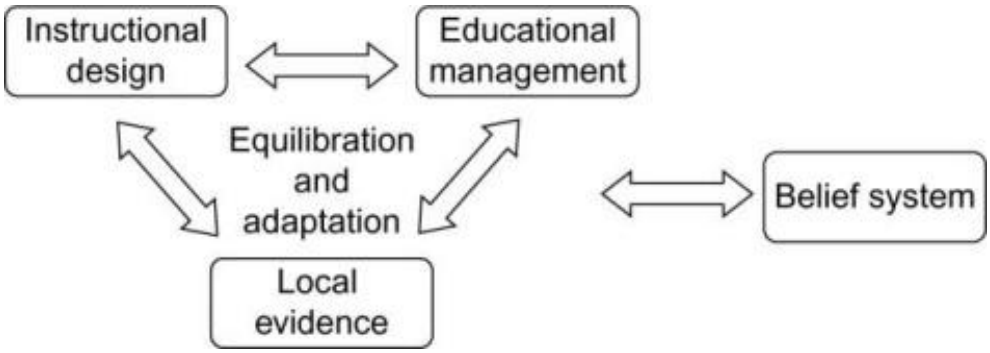

Figure 2.2: Framework promoting CT in e-learning – advances in medical education and practice (Gharib et al., 2016:276)

Conferring to Paul and Elder's (2008b:21) work on the CT Model as shown in Figure 2.3, the three components of CT are:

i. The **elements of thought,** also known as reasoning
ii. The **intellectual standards,** used to evaluate the reasoning capacity
iii. The **intellectual traits**, for cultivating CT

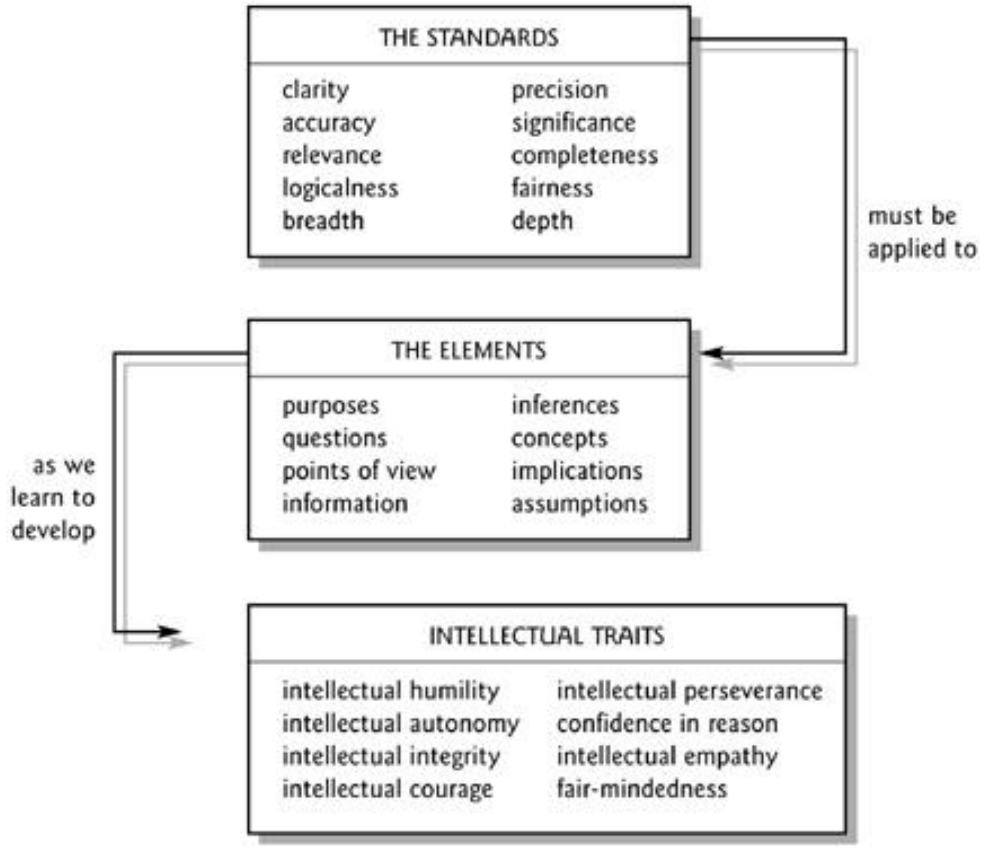

Figure 2.3: The Paul-Elder CT Model - miniature guide to CT concepts (Paul & Elder, 2008a:19)

The authors believe the intellectual standards to be the elements used to determine the quality of thinking and evaluate its excellence. They advocate the incorporation of these reasoning standards in all rational thoughts with the ultimate objective of progressed reasoning (Paul & Elder, 2008b). The intellectual standards include:

i. **Clarity:** Looking into further elaborating on a question, understanding and identifying a problem
ii. **Accuracy:** The facts in the information, understanding that the problem might be clear but not accurate
iii. **Precision:** More exact, detailed and specific information
iv. **Relevance:** The relation and appropriateness to the problem
v. **Depth:** The complexity of a problem or an issue
vi. **Breath:** Another point of view, perceptions and considerations to keep in mind when solving a problem
vii. **Logic (Judgement):** The reasonable sense in a question or comment; the orderly aligned various thoughts that are mutually supporting
viii. **Significance:** The ability to prioritise a problem in the order of importance
ix. **Fairness:** The ability to be considerate and open-minded given a situation

Magrabi, Pasha and Phasha (2018), in their recent study on the enhancement of CT skills in the engineering field of study, perceive CT skills to be an important factor that enables students to solve social, scientific, and practical problems effectively.

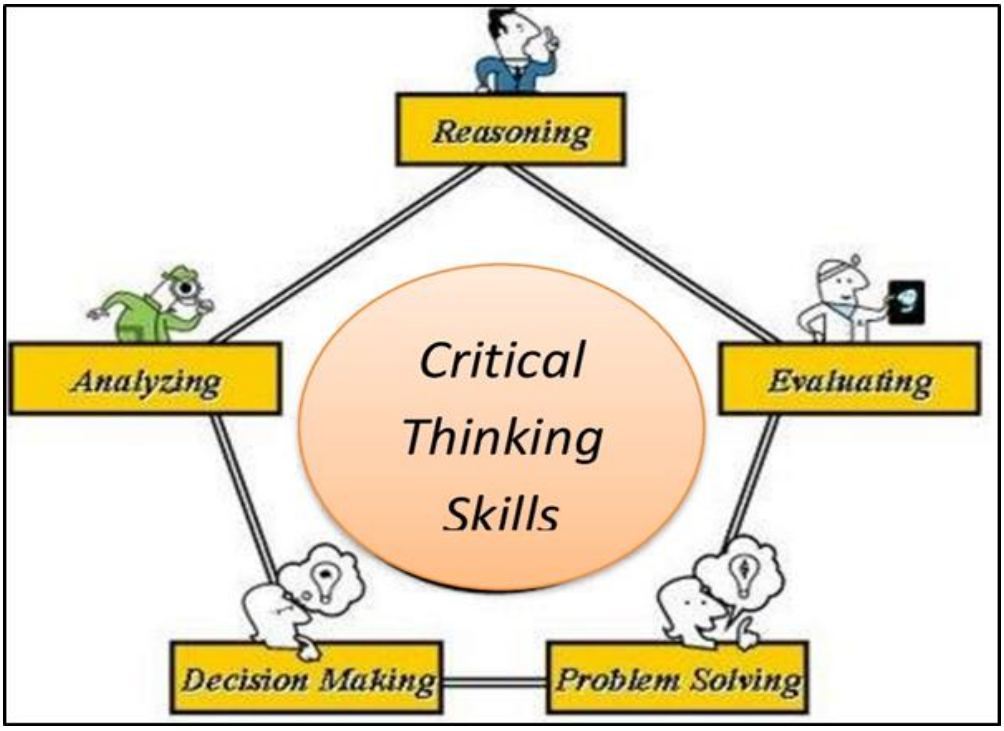

Figure 2.4: Critical thinking sequence (Magrabi, Pasha & Pasha, 2018:152)

Figure 2.4 shows how these authors describe the performance to be modelled by the faculty and the students towards the implementation of ways to teaching and evaluating CT skills in teaching and learning to improve problem solving skills. They have identified reasoning as the first step in the sequence, followed by evaluation of data, problem solving skills, and finally, decision making and data analysis. This CT sequence can be implemented individually or done as a collaboration of group work.

2.3 Games

Digital games are automated games established on highly structured rules involving human interaction and which generate visual feedback (Glover, 2013. In another study, video games are defined as “interactive activities that continually provide challenge and goal to the players by involving them in an active learning process to master the game mechanics” (Domínguez et al., 2013:380). Zhang and Kim (2018:3) highlight how interactive games assist in learner motivation and the skills needed for self-directive leaning. Playing games is not a new thing, and has been part of day-to-day living since the emergence of civilisation. Some scholars have also demonstrated that game play enhances brain activity and reaction, allowing long life

and delaying dementia (Tynjälä, Mason & Lonka, 2011; Pardina-Torner, Carbonell & Castejón, 2019).

According to Dichev et al. (2014:87), video games are proficient in their ability to engage users by using difficulty levels that cause people to be involved much longer, thereby developing their imaginative capacities and building relationships and trust between people. Games are known to excel in bringing about a calming and relaxing effect to the participant (player), which invoke interest, engagement and motivation to reach the end (Dichev et al., 2014). They are meant for pleasure, entertainment, and amusement.

A more detailed definition of a game is given by Juul (2003:2):

> "A game is a rule-based formal system with a variable and quantifiable outcome, where different outcomes are assigned different values, the player exerts effort in order to influence the outcome, the player feels attached to the outcome, and the consequences of the activity are optional and negotiable".

The latter definition is an explicit correlation of games with the teaching and learning process (Watson & Salter, 2016:101). The biggest concern, according to Johnson and Chibaya (2014), is the disparity brought by most educational games in that they are not fun at all, which creates the barrier between school and gaming.

Although games have the ability to engage students and to teach, entertain, motivate and even improve confidence, in some cases they did not (Codish & Ravid, 2012; Pardina-Torner, Carbonell & Castejón, 2019). Researchers are still in conflict with using games as 'stand alones' but they need to be includes as add-ons and aids to teaching and learning (Codish & Ravid, 2012). While games are proposed to be incorporated into teaching and learning, Ryan (2014) identifies the problems associated with the implementation of Game-Based Learning (GBL) pedagogical styles, namely whether assessments should be game-based or subject content-based, and infrastructural (software and access problems), organisational (insufficient time for the project) and pedagogical (lecturer's new role in the teaching and learning process) barriers (Ryan, 2014).

2.3.1 Game benefits

Digital games have a special role in one's mind as they motivate and encourage engagement, create curiosity and promote awareness of health wellness, especially with teenagers (Aleem, 2016). More people are exploring the benefit of social games where people play online with friends (Granic, Lobel & Engels, 2014).

Motivation is the essential advantage for game play (Tan, 2014; Chang & Hwang, 2019). Game playing may increase due to enjoyment, interest based on gaining rewards, the hope of moving to the next level of the game, or the fear of forfeiting rewards and thereby losing a life in a game (Aleem, 2016). Similarly, students may be pressured either positively or negatively to validate themselves during a problem solving class exercise to gain acceptance or avoid rejection from their peers (Muntean, 2011). Various scholars have encouraged the use of games for improved learning experience (Muntean, 2011). Social skills are perceived as public community engagement, thereby endorsing the ability to lead relevant social gatherings (Granic, Lobel & Engels, 2014). Games do not only enhance engagement, studies have shown that the children and young people enjoy playing video games because these games increase positive emotions or improve the mood of players (Granic, Lobel & Engels, 2014). Moreover, games have proven to improve concentration and accuracy in a study on psychological aptitudes (Granic, Lobel & Engels, 2014).

Other benefits for game play are repeated learning, which appears to be a less tedious activity than traditional learning, and peer modelling as an optimistic technique for teaching and learning (Tavakkoli, Loffredo & Ward, 2014). Bitter and Corral (2015) report improved learning outcomes with increasing emotional stability in their study on the impact of a Mobile Math application on students' learning outcomes.

The progression of cognitive thinking embedded in game play is another advantage (Gomes, Figueiredo & Bidarra, 2014). Gliga and Flesner (2014) report on intellectual and socio-emotional improvement after investigating the benefit of regular chess play in contrast to the regular soccer or baseball game. In a study conducted on three-dimension (3D) game play skills, it has been found that the effects are similar to those of formal educational courses intended to instil cognitive thinking skills (Granic, Lobel & Engels, 2014). The most thrilling benefit of digital game play is rewards. Rewards can be intrinsic or extrinsic – the ultimate target waiting to be achieved (Nicholson, 2014).

Games have been proven and it remains to be an effective learning tool. In the work done by de Freitas (2018), the author evaluates various games to determine the efficiency of games as a learning tool. The outcomes of this research revealed not only motivational benefits, but also how games were successfully used as an assessment replacement (De Freitas, 2018:74).

Gamification (section 2.4) is the use of game design elements and game mechanics in non-gaming contexts to assist with motivating and engaging users in certain actions. According to Knautz, Göretz and Wintermeyer (2014:690), game elements consider some aspects to be applied, including guild quests, achievements, point levels, rankings and stories in a precise context. The motive for these mechanics is to acquire a high level of engagement, improved performance and to stimulate innovations.

The realisation of the benefits of gamification yields an opportunity not only for academics, but also for corporate and employers in terms of improved employee performance and better customer engagement (Szeghegyi, Szoboszlai & Velencei, 2014).

2.3.2 Game design elements

Game design elements are defined as “concepts of rubrics and comment circles envisioned to produce gratification in game-playing”, also referred to as game mechanism and dynamics (Deterding et al., 2011:9). Codish and Ravid (2012:36) define game design elements as “the building blocks that can be applied and combined to gamify any non-game context”. Another meaningful definition is that “game design elements are not intended to describe a single method but may include game interface designs, game patterns, game design principles, game models and game design methods” (Wilson, Calongne, & Henderson, 2015:87). These game mechanics are used as intrinsic and extrinsic factors to increase learners’ motivation and learning in formal and informal environments.

Extrinsic factors can be defined as “those that the achievement is shown publicly like the awarding of rewards to the user and intensification of users to another level, which may be accountable for the user’s change in behaviour” (Diewald et al., 2015:5). Intrinsic factors are denoted by fundamentals such as improved self-confidence and self-dignity, which enable persistence, determination and deep engagement (Diewald et al., 2015).

According to Kalinauskas (2014), these game design elements are used to enhance interest and engagement into gaming activities. Deterding et al. (2011) posit that the main goal of including game design elements is for a ‘gamified’ experience. Sillaots (2012:539) identifies some of the game elements mostly used in gamification as:

- Collaboration in teams
- Competition among players
- Scoreboards and badges, rewards/points

- Clear rules/goals
- Instant feedback
- Game levels as units
- Risk of failing
- Randomness

The most used game elements in gamified applications are rewards/points, feedback and levels (Sillaots, 2012; Kalinauskas, 2014).

2.3.3 Game-based learning

The demand of electronic and online learning has increased due to the evolving educational system and new variances in educational experiences. Game-based learning is one of the variances in e-learning, which simply means that learning is supported by the use of educational (serious) games. This is customarily done in order to improve a certain proficiency in education. Harriehausen-Muehlbauer (2013:54) refers to game based learning as “games that take place in hard- and software-based virtual environments”, while Orszullok and Knautz (2014:1010) relate their definition to Prensky’s description of “the implementation of online games on an online platform with the use of partial didactic perceptions”.

Since curiosity is the driving force for keeping learners engaged in educational activities, game-based learning is the important influence to facilitate interest and engagement during teaching and learning (Jong, 2014). This topic has gained attention from many academics, as game-based learning (GBL) is perceived as the actuality of active, constructivist and collaborative learning, which fosters participation in problem solving, creativity and deep learning (Jayasinghe & Dharmaratne, 2013; Orszullok & Knautz, 2014; Tan, 2014).

Some researchers consider GBL as a more relaxed learning approach for its playful, achievement and rewards which may include acquisition of knowledge, higher accuracy and improved memory (Jayasinghe & Dharmaratne, 2013; Orszullok & Knautz, 2014; Tan, 2014; Ronimus & Lyytinen, 2015). Fan and Xiao (2015) identify some of the functions of games as assisting in exploring new skills, practicing skills, promoting self-dignity, and of course, teaching and entertainment.

Chang and Hwang (2019:81) classify gamification as a “type of games”, as they explore the researches done on GBL in a little less than a century (2007-2016). The authors indicate how gamification studies take the third place in international publications. Moreover, the outcomes of gamification exercises indicate better

learning achievement and a higher level of motivation in learning for the students who participated in the studies (Chang & Hwang, 2019).

2.4 Gamification

Games have the technique, ability, and resources to attract, while motivating, encouraging, and engaging in the custom of rewarding the user (McKernan et al., 2015). Designing an engaging game "involves the conception and design of rules to immerse players in fun activities" (Ibanez, Di-Serio & Delgado-Kloos, 2014:1). Game elements are therefore the best way of incorporating game principles in non-game environments. Based on the definition of games stated above, it is clear that most of the game elements are compatible with formal learning, but with the difference that failing in terms of results can have more serious repercussions than that of a game.

Ibanez, Di-Serio and Delgado-Kloos (2014) have identified the two primary intention for gamification in education, (1) to alter the student learning behaviors, by fostering learning engagement and promoting active participation in teaching and learning environment, and; (2) to engage students in the teaching and learning process. Therefore, gamification is not only beneficial in encouraging student engagement, but also can be used to discourage dishonest students behaviour (Ibanez, Di-Serio and Delgado-Kloos, 2014).

According to Nicholson (2014:4), a meaningful way to "think" of a gamified milieu is a three-dimensional real-world space where game elements, which include a thorough exploration of play, exposition, choice, information, engagement, and reflection, are used instead of a linear reward-based system. This would then provide the participants with enough information needed for decision making in terms of the system.

Kalinauskas (2014:69) investigates the use of flow theory, which he defines as "a state of saturation where knowledge and emotion engagement is at its maximum". This state of engagement encourages even failures to improve their experience in mastering the challenge, which is one dominant element used in games to keep the gamers engaged. Thus, this flow theory endorses the dynamic concepts found in game design advocated by Dichev et al. (2014:86), which are freedom to fail, prompt feedback, progression, and rewards. Gamification does not imply creating or designing games, but rather making teaching and learning more entertaining and engaging without taking away its influence.

This research assumes the description of gamification based on de Freitas (2018:75), namely the use of game elements or techniques in a non-game (playing) environment.

2.4.1 Gamification definition

Gamification has been defined by various researchers as the use of game-based mechanisms and game thinking in a non-game context to encourage engagement, and to enhance and improve performance and retention (Tynjälä, Mason & Lonka, 2011; Deterding et al*.,* 2011; Jayasinghe & Dharmaratne, 2013; Dichev et al., 2014; Harman, Koohang & Paliszkiewicz, 2014; Kalinauskas, 2014; Knautz, Göretz & Wintermeyer, 2014; Laskowski & Badurowics, 2014; Lindermann et al., 2014; Orszullok & Knautz, 2014; Vehns, 2014; Seaborn & Fels, 2015; Alsawaier, 2018; De Freitas, 2018). However, Nicholson (2014) views gamification as synonymous with rewards. Folmar (2015:2) defined gamification in a diverse manner from most philosophers, as “the use of game thinking and game mechanics, to meet non-game ends”.

Gamification applications are not merely limited to the classroom educational setting, it has also found its way in almost all business sectors, including health, politics, marketing, and even social network (Szeghegyi, Szoboszlai & Velencei, 2014; Vehns, 2014; Sedighi, 2015; Hammarfelt, Rijcke & Rushforth, 2016; Schofield et al., 2016; Ihamäki & Heljakka, 2017; Carmona, Cîrlig & Sgueo, 2017).

Hamari, Koivisto and Sarsa (2014:3026) define gamification as “a procedure to advance facilities by means of motivation in order to stimulate gameful experiences and other interactive concepts”. In gamification methods, the game elements are not the epicentre of the system, but it motivates users to make use of these methods.

Huang,Hew and Lo (2019:255) emphasis the distinction between the “gamification”, “game-based learning (serious games)” and “full-fledged games” by highlighting the **elements** and **non-game context** in their definition for gamification.

According to Yurov et al. (2014:171), gamification is “perceived as another way used to describe serious games or education games to promote user experience and engagement”. Yurov et al. (2014) further explain that gamification allows for knowledge to be distributed in different stages of learning. Figure 2.5 shows a gamified activities framework that can be used as guide for implementing gamified activities in a classroom setting (Yurov et al., 2014).Consequently, from all the literature consulted, the adopted definition of gamification used as foundation in this

study, is the utilisation of game elements, techniques and concepts in a non-game context with the goal of engaging and motivating people with certain tasks.

2.4.2 Gamification models

According to Figure 2.5, the CONTEXT symbolises the course content. in particular the subject matter, which has to be related to the gamified learning activities that have to be learned. The TASK, referring to missions to be solved, relates to the LEVELS of different themes of the subject matter. STORYTELLING relates to the engagement that stimulates the imagination of listening and storytelling students. FEEDBACK is the most important part of gamified applications, especially since it is immediate and motivating, and includes rewards and punishment. Finally, the LEADERBOARDS relate to ranking, whereby the leading students are displayed.

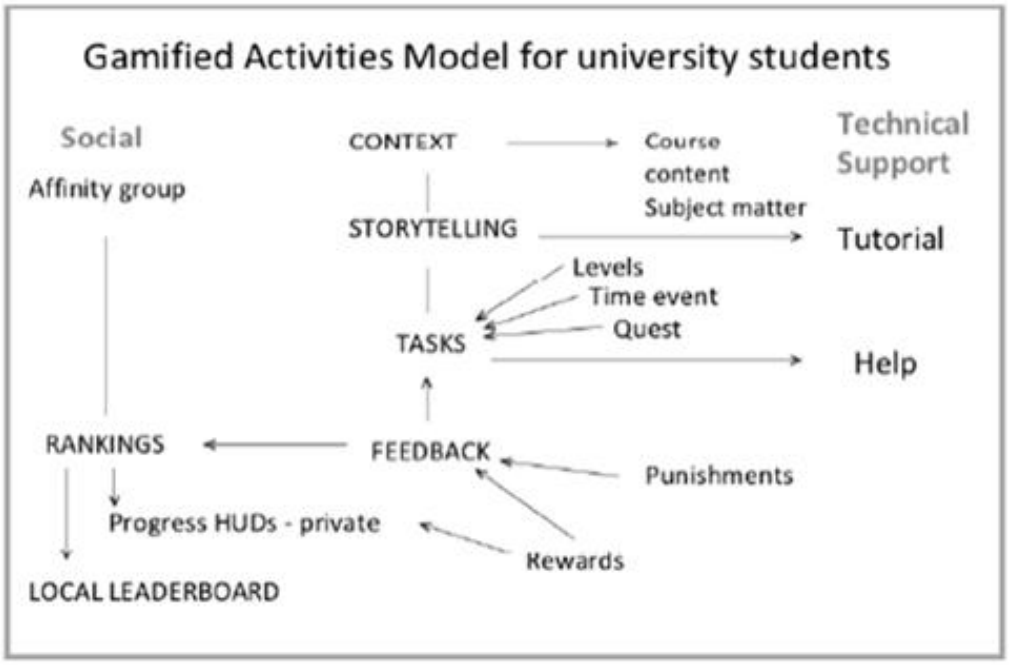

Figure 2.5: Framework for gamified activities (Carvalho, Araújo & Zagalo, 2014:95)

Research has confirmed that Generation Z, also known as “Gen Next” or “iGen”, has decrease in terms of paying attention, which might be addressed through gamification (Bíró, 2014). Bíró (2014:150) posits that Generation Z prefers the use of technology more than previous generations, and they are better trained in using technology. This has been affirmed in a study conducted by Wilson, Calongne and Henderson (2015:87), who determined the challenges associated with gamification definitions. These scholars have identified and investigated the definitions of gamification using 29 articles to classify commonalities, where after they proposed a supporting model for gamification design. In all the gamified systems, the game

design elements have been found to be the catalyst used in motivating the user to complete a task, which is where the grading and rewards are established.

Figure 2.6 describes the distinctions between the game design elements, playful games, game-based learning, and gamification. In this two-dimensional diagram of playing/gaming (gaming for a purpose) and (no gameplay) part/whole (gameplay), the playful designs and toys can be differentiated through the (playing is for fun) playing/gaming dimension. Furthermore, games and serious games are differentiated from gamification through the part/whole dimension (Lombriser & Van der Valk, 2011). Therefore, a game-based learning approach is partly playful and partly purposeful, as it uses digital games for learning (Jayasinghe & Dharmaratne, 2013). The gamification approach does not have to be playful, but it must be purposeful (Hamari, Koivisto & Sarsa, 2014).

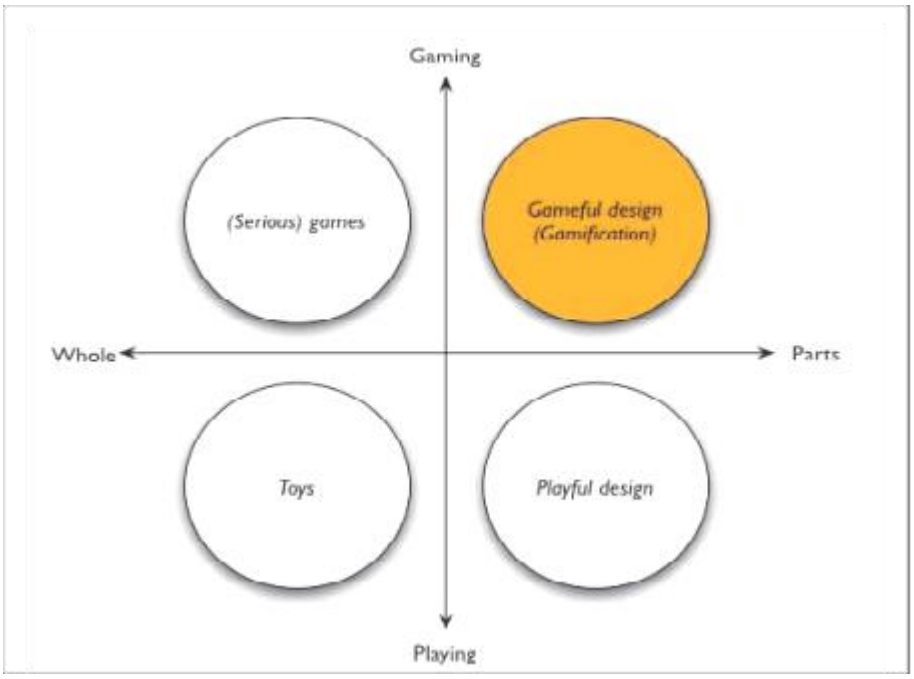

Figure 2.6: Gamification between game and play, part and whole (Deterding et al., 2011:7)

2.5 Summary

In this chapter, literature on CT skills and gamification has been reviewed. CT is one of the most important skills to be acquired. Literature states the significance of teaching and assessing CT, not only for tertiary students, but from as early as possible in life. CT skills turn out to be important in the workplace. Gamification promotes engagement, loyalty, and performance, which is desired by all companies and merchants. It is proposed that CT may be improved through gamification.

Chapter Three describes the detailed research design adopted for the study.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

The aim of this research was to explore the effect of gamification on the critical thinking skills of ICT students. In order to answer the research questions and to fulfil the aim of the research, this chapter is dedicated to the research methodology adopted.

This chapter is outlined as follows: i) research methodology; ii) research philosophy (ontology, epistemology, axiology); iii) research approach (deductive and inductive); iv) research strategy (action research and interviews); v) intervention; vi) data collection (quantitative and qualitative); vii) data analysis; and vii) ethics.

3.2 Research methodology

Research methodology is defined as the science of studying the systematic processes followed by a researcher to gain knowledge (Kothari, 2004). The first section of this chapter focuses on the justification for selecting the research method, followed by the outline of the research philosophy, research approach, research strategy, data collection, sampling, and the unit of analysis.

Venkatesh, Brown and Bala (2013) identify mixed and multi-method research as types of multiple method research. Hall (2013:1) defines a multi-method as "combinations of methods which yield data of the same kind". Creswell et al. (2003:165) define mixed methods research as:

> "…the collection or analysis of both quantitative and/or qualitative data in a single study in which the data are collected concurrently or sequentially, are given priority, and involve the integration of the data at one or more stages in the process of research".

Therefore, multi-method research is conducted using either a single paradigm or multiple paradigms, whereas mixed methods research is conducted by combining different research methods (i.e. qualitative and quantitative research methods) (Venkatesh, Brown & Bala, 2013). These scholars perceive all mixed methods research studies to be by definition multi-method research, but not all multi-method research studies are mixed methods research (Venkatesh, Brown & Bala, 2013). Creswell et al. (2011:4) perceive mixed methods researchers as "often making explicit diverse philosophical positions", and in this manner, they have different beliefs that may be transformed into new knowledge. The motivation for uniting the qualitative and quantitative research approach is to provide a more comprehensive

and thorough understanding of a research problem than either approach on its own (Creswell, 2008).

An intervention multistage mixed methods approach was used for the study, whereby the quantitative (action) and qualitative (interviews) findings and results are presented in different stages as each data section is analysed. This framework was used in order to gain a comprehensive understanding of how the gamification intervention can be related to improved CT skills of ICT students in a tertiary institution.

A cross-sectional research design was deployed, where different levels of students enrolled for ICT in a tertiary institution in South Africa were given (pre- and post-intervention) questionnaires to complete. Different modules of the Diploma students were included to reinforce the nature of the study. This also identified the students' interests in gaming and subsequently their categories of gaming.

3.3 Research philosophy

Research philosophy relates to the process of developing new knowledge in a particular field. The pragmatic stance was assumed for this research, as it attracts the engagement of 'what works', with the focus on the research problem and research question and applying diverse approaches to anticipate results that answer the research question (Saunders, Lewis & Thornhill, 2009; Hall, 2013). Saunders, Lewis and Thornhill (2009) identify the three primary research philosophies as ontology, axiology and epistemology. These philosophies assist researchers with constructing, assessing, and deciding on an investigation process that will enable the researcher to distinguish between the assumptions made and the knowledge produced by cross-examining and testing the process. The three research philosophies are discussed in the next section.

3.3.1 Ontology

Pratt (2013:89) describes ontology as a "primitive subject in all philosophies about existence, whether it be made explicit or remain tacit". Easterbrook (2014) contends that systems thinking may be the remedy for domain ontology for sustainability reasoning. Ontology focuses on how people see the world. The two commonly agreed ontological worldviews (objectivism and subjectivism) are identified, which have been described as a continuum's polar opposites with varying philosophical positions aligned between them (Holden & Lynch, 2004; Hall, 2013).

3.3.1.1 Objectivism

Objectivism is an ontological position that emphasises the existence of social entities in a reality external to social actors concerned with their existence (Saunders, Lewis & Thornhill, 2009).

3.3.1.2 Subjectivism

Subjectivism is an ontological position that relates to the view that social phenomena are created from the perceptions and consequent actions of those social actors concerned with their existence (Saunders, Lewis & Thornhill, 2009). Huizing (2007:93) defines subjectivism as "supplying an alternative account in which human experience and understanding instead of objective truth occupies the central stage".

The research view of this study is that social interaction is an important feature of teaching and learning, especially when the intention is to develop knowledge that will be relevant to practice, as inter-subjective meaning is assigned to human beliefs and understanding (Huizing, 2007:96). Furthermore, this research is based on the believe that teaching and learning has an influence on the (students) learners' behaviour and reasoning, and that teaching and learning should be intended to efficiently transfer objective knowledge to the learner's mind (Vrasidas, 1995). The researcher assumes an ontological stance of subjectivism due to the nature of the study, where quantitative and qualitative data have been interpreted from a subjectivist view.

3.3.2 Axiology

Axiology is a philosophy that concerns the values (ethics and aesthetics) of the researcher. According to Saunders, Lewis and Thornhill (2009), Hall (2013) and Vehns (2014), research is value bound, which means that how people do research is guided by their human values. Vehns (2014) believes that researchers cannot be disengaged from what is studied; they are part of what is being researched. The knowledge and experience of the researcher may be a hindrance to the findings of a research study. Therefore, although being an operative affiliate in the ICT department, the researcher in this study preserved her objectivity throughout the research.

3.3.3 Epistemology

The term epistemology (what is known to be true) describes the prospects and assumptions about the knowledge and the way in which it may be attained. Becker and Niehaves (2007:201) define epistemology as "the science of analysis on how

human beings comprehend the perceived existence of knowledge". Saunders, Lewis and Thornhill (2009) believe epistemology has to do with what determines satisfactory information in a field of study. The four worldviews of epistemology, namely post-positivism, constructivism, transformativism and pragmatism, allow the researchers to embrace the suitable research approach for their studies based on their individual beliefs (Creswell, 2008). These worldviews may result from faculty orientations as well as lecturer (researcher) inclinations and research experiences. These views are shown in Table 3.1 and discussed below.

Table 3.1: Four philosophical worldviews (Creswell, 2008:6)

Four Worldviews	
Post-positivism • Determination • Reductionism • Empirical observation and measurement • Theory verification	**Constructivism** • Understanding • Multiple participant meanings • Social and historical construction • Theory generation
Transformativism • Political • Empowerment issue-oriented • Collaborative • Change-oriented	**Pragmatism** • Consequences of actions • Problem-centred • Pluralistic • Real-world practice oriented

3.3.3.1 Post-positivism (and positivism)

Positivists believe that only a single standardised instrument can be used to observe and measure a neutral objective reality; they design their work to assess their informed hypothesis (Kvale, 1996). Contrary to this, post-positivism emphasises a determined necessity to observe and measure the causes that influence outcomes (Creswell, 2008).

3.3.3.2 Transformative paradigm

A transformative paradigm places the emphasis on the stance that the research questions should be interlinked with politics and political change agendas to challenge any level of social domination that may occur; therefore, the researcher's interest is in transforming and improving the lives of the participants involved in the research (Creswell, 2008).

3.3.3.3 Interpretivism (constructivism)

Interpretivism (or constructivism or social constructivism) is characteristically viewed as a qualitative research approach (Creswell, 2008). Social constructivists believe that individuals develop subjective meaning and understanding of their experiences

about certain objects (Creswell, 2008). Constructivists are concerned with the way in which individuals observe and interpret the measures and meanings they bring to a situation. They therefore take into account that groups of people form, that these groups share their meaning with each other, and that they understand each other (Kvale, 1996). According to Becker and Niehaves (2007), the interpretivist research approach focuses on the researcher's personal attempts to acquire knowledge and rigorously apply research methods that aim to influence a specific subject.

3.3.3.4 Pragmatism

Pragmatism is concerned with the application and solutions to the problem that may arise from actions, situations, and consequences rather than with previous conditions as post-positivists do (Creswell, 2008). Hilliger (2012:12) perceives pragmatism as a worldview that "gives a researcher the ability to create knowledge without getting hung up on rigid processes, which may lead to the exclusion of valuable data". Giannakopoulos (2012:276) refers to pragmatism as "a key to deep understanding". Pragmatism encourages innovative theories as outcomes through active and controlled experimentation (Giannakopoulos, 2012).

Some researchers believe that the pragmatic stance is the most appropriate approach for the mixed methods studies (Creswell et al., 2003; Plano Clark et al., 2008; Saunders, Lewis & Thornhill, 2009; Venkatesh, Brown & Bala, 2013). Venkatesh, Brown and Bala (2013) posit that pragmatism is "the best paradigm for justifying the use of mixed methods research". Scholars such as Creswell et al. (2003) and Plano Clark et al. (2008) suggest that pragmatism is used as a foundation in mixed methods studies since they embrace a philosophical position that varies by design type. However, Hall (2013) argues that pragmatism does not enter into the choice of research design (mixed methods) nor does it justify its use. For this study, the stance of Creswell et al. (2003) and Plano Clark et al. (2008) have been adopted as the epistemological position of pragmatism.

3.3.3.5 Conclusion

The pragmatism paradigm was adopted for this study as the researcher explored practical concerns in enhancing and evaluating CT skills and interpretive knowledge in the use of gamification. It is imperative to correlate the perceptions of both the researcher and the participants on the authenticity of using gamification in order to reach the resolution based on the research questions. The researcher has adopted the most critical interpretivist stance for the study (Saunders, Lewis & Thornhill, 2009).

3.4 Research approach

Research approach refers to a body of practices, procedures, and rules used by those engaged in research. It embodies the philosophies and paradigms embraced by the researcher. This research, based on the nature of data collection and analysis, has embraced the mixed methods explanatory research methodology (triangulation) due to its predictability to the type, design, and pragmatic stance of the research. This study has followed both the inductive and deductive approach. According to Venkatesh, Brown and Bala (2013), a pragmatic approach is based on "abducting reasoning that moves back and forth between [the] inductive and deductive" research approach, thereby considering the practical consequences as well as the fundamental meaning and truth. The two approaches are discussed in the following section.

3.4.1 Deductive approach

The deductive approach allows the researcher to move from general principle to a specific conclusion while generating a conceptual framework and hypothesis from either constructive or contrasting philosophies in literature. The hypotheses are generated to instigate a research inquiry and to predict the desirable outcome of the research, with the influence of the intervention. Due to the nature of the research design (which includes both quantitative and qualitative research) being cross-sectional quasi-experimental research, and due to the non-random selection of the participants, an unpremeditated hypothesis is tested (White & Sabarwal, 2014).

The central hypothesis of this study is that the students' level of CT would differ across the three different years of study or levels. It is hypothesised that the intervention (gamified presentations) applied after the CT pre-test, will have a positive impact on the experimental groups compared to the control group. The following tests were done to test the hypothesis for this study:

Null Hypothesis H_0: there is no significant difference in the percentage correct CT scores (marks) between the CT pre-test and the CT post-test, formulated as:

- $H_0: p_1 = p_2$

Alternative H_1: there is a significant difference in the percentage correct CT scores (marks) between the CT pre-test and the CT post-test, formulated as:

- $H_1: p_1 \neq p_2$

The CT skills were divided into five different elements namely:

i. Problem identification
ii. In-depth clarification
iii. Judgement
iv. Inference
v. Strategy formation

These five elements were examined to determine the variance between them. The CT skills elements were evaluated across the three different years (1st, 2nd & 3rd) of study. The following hypothesis was formulated:

1**H_o: $\alpha_1 = \alpha_2 = \alpha_3 = 0$:** This was done to test the CT skills elements between the three different years, hypothesising that the CT skills are equal in all (1st,2nd, & 3rd) year levels **($\alpha_1 = \alpha_2 = \alpha_3$).**

2**H_o: $ß_1 = ß_2 = ß_3 = ß_4 = ß_5$:** This was done to test for any significant difference between the five CT skills elements – Problem identification (**$ß_1$**), In-depth clarification (**$ß_2$**), Judgement (**$ß_3$**), Inference (**$ß_4$**) and strategy formation (**$ß_5$**).

3**H_o: $(\alpha ß)_{11} = (\alpha ß)_{12} = (\alpha ß)_{13} = \ldots = (\alpha ß)_{35} = 0$:** Lastly, this test was done to verify if there is any significant difference in the interaction between the CT skills and the years of study.

3.4.2 Inductive approach

Inductive reasoning identifies patterns and themes from the researcher's proceedings (Pieterse, 2012). Nonetheless, conceptual frameworks are discouraged by some scholars, as they are believed to be restrictive to inductive methods and favour to the deductive approach; conceptual frameworks are perceived to be controlling in nature, as they encourage researchers to be too driven by their own thoughts and decisions (Baxter & Jack, 2008). Because the quantitative research approach is deemed deductive, and the quantitative data portray inductive reasoning, this study adopted both the inductive and the deductive approach.

The research follows the mixed methods approach, which combines qualitative and quantitative research. Some scholars refer to mixed methods research as methodological triangulation, since it uses triangulation with data collection and integration of interpretation phases (Creswell et al., 2003).

Figure 3.1 portrays the concurrent triangulation mixed methods design.

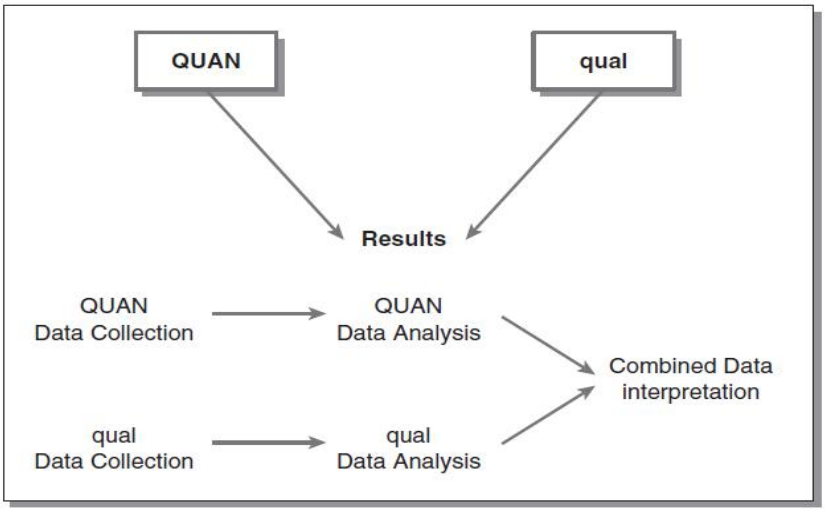

Figure 3.1: Concurrent triangulation: designing and conducting mixed methods (Creswell et al., 2003:192)

Figure 3.1 shows the two different methods during data collection, followed by the combined supporting data at the analysis stage by means of a joint display (section 4.6, Table 4.12), which conveys a thorough understanding of the gained information by bringing together the separate quantitative and qualitative results. It is clear that priority is given to the quantitative study, followed by the qualitative study (Creswell et al., 2003). This is the representation of how data were collected and analysed for the recent study.

Quantitative data were first collected from a selected sample of all relevant groups (1st, 2nd and 3rd year students) in the form of surveys as the pre-data, where after it was analysed before the post-data were collected. The analysed pre-data (measured pre-test CT skills) were used to determine the existence of CT in the different groups; the post-data were then collected. Next, the qualitative data were collected by conducting interviews with lecturers teaching the relevant ICT modules. The two data sets (qualitative and quantitative) were individually analysed. Finally, the analysed results were merged with the intention that the qualitative (interviews) study results may or may not support the quantitative (questionnaires) results.

3.5 Research strategy

Creswell (2008) relates to research strategies as the researcher's fundamental logical assumptions and the specific method used to conduct the research. The quantitative part of the research was conducted using a pre-test and post-test comparison design; therefore, a pre-test and post-test quasi-experimental research strategy with three non-equivalent conditions or research groups (two experimental groups and one control group) was employed.

Most scholars describe quasi-experimental research strategies as similar to experimental strategies that test the hypothesis (Creswell, 2008; Behar-Horenstein & Niu, 2011; Giannakopoulos, 2012; Krampen, 2012; Bensley & Spero, 2014; White & Sabarwal, 2014; Rodriguez, Soria & Campo, 2015). White and Sabarwal (2014:10), define quasi-research strategies as experimental research strategies that "offer practical options for conducting impact evaluation in a real world setting". This strategy lacks conditional random assignment, i.e. comparison groups that are pre-existing or self-selected with similar pre-intervention characteristics.

The research was done based on convenience and the availability of the institution to the researcher. In this study, the case was a University of Technology. The pre- and post-data were collected from the first year, second year and the third year students across different ICT modules, with the second and third years involved with the intervention after the pre-test was done (see section 3.5.1.3 on sampling). This study supported cross-sectional methods using structured questionnaires and interviews (semi-structured questionnaires) for data collection (Creswell, 2008; Seaborn & Fels, 2015).

3.5.1 Quasi-experiment

Since a mixed methodology was used, the strategy section is divided into two sub-sections, namely the quasi-experiment and the interviews. These sections also cover the gamification intervention where a pre- and post-test were conducted with the participants.

3.5.1.1 Intervention

The intervention consisted of the students gamifying the oral presentation to determine the impact of the gamification on the CT skills of the sample group. The focus was on the intervention to evaluate whether the intervention had any impact (positive or negative) on the students' CT skills. The intervention took the format of gamifying a presentation by the 2nd and 3rd year students. The 2nd year students gamified a business scenario whilst applying the subject contents of the course. The 3rd year students gamified a presentation of an existing business where they used the business information (with the assistance and permission of the business mentor) to submit weekly (nine) deliverables in the form of assignments (including meeting minutes or any conversation with the business mentor as proof of communication) based on the module requirements. The control group did not do the gamification.

The customary formal assessment (according to the institutional assessment policies) for the two modules is as follows:

- Second year students (Information Systems 2) have to do two formative assessments and an assignment (using a business scenario to apply the subject contents) and finally a summative assessment in the form of an examination
- Third year students (Business Analysis 3) have to do a project by identifying an existing business and use the business information (with the assistance and permission from the business mentor) to submit weekly (nine) deliverables in the form of assignments (including meeting minutes or any conversation with the business mentor as proof of communication) based on the module requirements. These assignments are used as a summative assessment, which is then followed by the examination at the end of the semester

The intervention (gamified oral presentations) was then introduced at the end of all the formative assessments and independent of the customary assessments. In both cases (2nd and 3rd years) the students were not required to do any oral presentations, hence the introduction of presentations as the intervention. The students were to use their assessments (assignment and project respectively) to convert to a gamified presentation in class. Since all the participants did not have oral presentation skills as a constituent to their standard assessments (as explained in section 3.5.1.1 above), the gamified oral presentations were added to their schedule. The following section describes the intention of oral presentations for the study, and the distinction between the evaluations of the customary and gamified oral presentations.

3.5.1.2 Oral presentation skills

Oral presentations are a good way of integrating CT in a teaching and learning environment (Paul, Elder & Bartell, 1997). Normally, oral presentations in a standard teaching and learning setting are primarily evaluated using the following oral presentations assessment criteria:

i. Presentation skills
ii. Structure of the presentation which has to do with how students arrange their work from the introduction to the conclusion of the presentation
iii. The relevance of the content that should be displayed in the presentation
iv. The ability to analyse the content and the demonstration of understanding the link between theory and practice

According to (Mogale, 2012), oral presentations are used during an interactive stage to assess reflection, as they assist students to reflect knowledge of the subject

matter, conciseness, logic and an ability to answer questions. Saad and Majid (2014:110), argue that, “presentation skills are featured as some of the highly important skills demanded from students among the employers”. Students are encouraged to participate and contribute actively in the question and answer session after presentations, as this is an active form of learning which demands preparation and participation (Mogale, 2012:225). Paul, Elder and Bartell (1997) recommend that teachers use the questioning technique to inspire CT in the classroom, since it is perceived as an essential part of learning.

Table 3.2 displays the difference in how the gamified oral presentation skills (the intervention) were evaluated in this study versus how oral presentation skills are customarily evaluated with university assessment programmes.

Table 3.2: The distinction on how the oral presentation skills are evaluated

Customary oral presentation skills evaluation	Gamified oral presentation skills evaluation
• **Scores** based on the presentation skills	• **Scores** – rewards are given or collected for each presentation per individual as scores based on the presentation skills and adherence to the rules stipulated
• **Structure** of the presentation – has to do with how students arrange their work from the introduction to the conclusion of the presentation • **The relevance** of the content should be displayed in the presentation • **The ability to analyse** the content and the demonstration of understanding the link between theory and practice is important	• **Rules** – the rules for the presentation were given, such as the length, the time for the presentation, and the number of slides per presentation
	• **Interaction and engagement** – the participation of other students in the presented presentation, the ability to respond to the questions and the attitude towards advice from peers
	• **Effort** –determination to do the work, individual preparedness, communication of team member(s) (if more than one member in a team)
	• **Role plays** – the assumption of different role characters by the team members during the collection of data and the actual classroom presentation
	• **Instant feedback and performance review** – the immediate and continuous response grading, allowing another chance for improvement

The objective of using oral presentations as the intervention was mainly to combine the emphasis of developing CT skills with retaining subject content knowledge. The

focus of the researcher for this study was not evaluating the intervention *procedure, but* on whether the intervention *per se* had any impact on the students' CT skills after the gamified oral presentations.

In this study, the researcher focused on the gamified assessment criteria, which include game mechanisms (section 2.3.2) to gamify the oral presentations. A gamification model described in Chapter Two (section 2.4.2; Figure 2.5), demonstrate the transition from normal teaching and learning activities to gamified activities for tertiary students. Carvalho Araújo and Zagalo (2014) said that gamified activities can be used to motivate students to learn and engage in learning anything (any subject content) and at anytime and anywhere (time and place is not a barrier). The intervention procedure (gamified oral presentations) in this study was therefore gamified using game dynamics related to scholars. For the gamifying of the presentation, the following (game) features were observed during the student presentations:

a) Scores

LOCAL LEADERBOARD (ranking), referred to by Carvalho, Araújo and Zagalo (2014: 95)is, where rewards or badges are given or collected for each presentation per individual or group, as scores based on the presentation skills and adherence to the rules are stipulated. Scores are primarily decided by the audience. The role of the lecturers, including the researcher, is merely to facilitate the programme and support the students. Other assessing tools for scores include:

i. Clarity, how clearly the presentation was delivered
ii. Logic, the order in the presentation of the material
iii. Constructive participation
iv. The ability to summarise
v. Ability to link new views to own experience

b) Rules

The rules in a presentation setting are viewed as a rubric (Appendix D) and are the most important feature of the presentations, especially since most of the points or scores are merely based on adherence to the specified rules. Mogale (2012:196) defines a rubric (Appendix D) as "a scaled set of criteria that clearly define for the learner and facilitator what range of acceptable and unacceptable performance looks like". Wilson, Calongne and Henderson (2015:92) believe that the use of gamification designs in rubrics reduce anxiety and encourage teamwork. According to Carvalho, Araújo and Zagalo (2014:95), the TASKS and LEVELS (section 2.4.2, Figure 2.5) go together and determine how the subject content activities will be

assessed or evaluated at different stages. Rules for the presentation were provided to all the participants and facilitators before the presentation occurred. These rules (Appendix D) include:

i. The length of the presentation
ii. The use of inappropriate humour
iii. The relevance of the topic
iv. Giving the audience an opportunity to comment or ask questions (clarity) about the presentation
v. The number of slides per presentation

c) Interaction and engagement

The students' contributions are important as they are the primary score identifiers. The goal of the lecturer is not to grade students' performance but to facilitate the order of the presentation process. Gamification suggests a social gameful interaction phenomenon that inspires student interaction with other participants, thereby triggering intrinsic gaming motivation. The engagement and interaction of other students in the classroom (audience) to the currently staged presentation is mandatory. The ability of the presenter to respond to the questions and his/her attitude towards advice (or positive criticism) from the peers (audiences) is carefully observed (constructive participation).

d) Effort

Allowing the participants to view and work according to the rubric is another significant constituent of gamification as the students are encouraged to score the highest points and allowed to 'redo' a task until all the afforded chances are exhausted (Appendix D). The determination awarded to the work, individual preparedness, and correspondence of a team member is awarded and acknowledged. This topic can also be linked to levels, as students may be motivated to move from one level to another through their progress given by their peers.

e) Role plays

Role play is defined by Zamboanga et al. (2016:243) as the "type of learning activity that can be used to enhance students' understanding of any course from any discipline materials". Supplementary to the prior definition, the role plays allow students to experience and view activities that resemble a real-world phenomenon across various viewpoints. Johnson et al. (2013:10) believe role playing to be "a vital part of learning as it allows students to reconstruct problematic situations to try new retorts or stance creativity". According to James (2014:14), students can "role-pay" any character "in order to escape the background which might affect the way they

think about everything". This means that students will be ready to take on any identity that they have never thought of in order to obtain scores or points.

Zamboanga et al. (2016) perceive role plays as tools to teach emotional and expressive relational domains. McSharry and Jones (2000:73-74) describe role plays in terms of science as "a product of the use of drama, games and simulations"; the authors also consider presentations as a role play category. Furthermore, the two scholars continue to identify some of the benefits of role plays that contribute towards students' learning as follows:

i. It gives the students a feeling of 'ownership' of their education
ii. It can be used effectively to teach about moral or ethical issues from the curriculum
iii. Gives students a chance to experience the events which may be appropriate to their personal learning styles
iv. Helps students to conceptualise and greatly increase learning

f) Instant feedback and performance review

The immediate and continuous response and grading allow for another chance of improvement. Feedback is an important part of CT, as it allows the student and facilitators to discuss what works or what does not work in terms of performance criteria and assessment standards. For example, after each presentation, the audience give their comments and grading based on the rubric given to them. Should the presenter not be satisfied with the score obtained, they are given another chance to redo the presentation with the input and direction from the facilitator. Most scholars agree that instant feedback promotes intrinsic motivation and allows one to assess his/her individual performance (Lombriser & Van der Valk, 2011; Sillaots, 2012; Domínguez et al., 2013; Gromuls, 2013; Dichev et al., 2014) Feedback can be delivered in the form of points or scores, symbolising one's progress on the presentation. Carvalho, Araújo and Zagalo (2014) observe FEEDBACK as rankings which may lead to rewards and punishment in a gamified environment. Ylikoski and Oksanen-Ylikoski (2014:3) perceive instant or immediate feedback in a gamified environment as an influence of earnestness and imminence, which permits the user to have confidence in controlling the results.

3.5.1.3 Sampling

The population selection is from an ICT department of the campus delivery site of a University of Technology in Gauteng. This research followed the definition of sampling rendered by Verhoef and Hilsden (2004), where the selected portion of the target group in a sample is perceived as a representation of the entire population

(ICT students at the UoT) of interest. The sampling frame selected for the study comprises a purposive and convenient sampling technique accessible to the researcher and permissible for data collection from the students on the registration class list accessed via the university registration online system. Consequently, the relevant class lists for the participating students were derived from the registration system, authorised by germane module lecturers.

The students were divided into three different groups, separated by the years of study and the modules studied at different year levels. The modules/subjects were chosen in such a way that the same student could not be exposed to more than one module at a certain time during a single registration period, therefore choosing subjects that carry prerequisites of one another.

The students were initially given a pre-test to determine the groups' (class/year level) CT levels. The CT questions used to measure the CT skills are questions in a questionnaire (Appendix A, section 2 of the questionnaire), used for data collection and as measuring instrument. The CT questions in the questionnaire were drawn from the Critical Thinking Foundation, which was used to assess the students' CT skills. The pre-test was taken by all participants (control group and experimental groups).

The pre-test was then followed by the gamified presentations in the case of the experimental group (the 2nd and 3rd year students). The intervention was supplementary to customary formal assessments; the motive for this was to neither interrupt the learning programme nor interfere with the students' assessments grading.

The participants were divided in three groups: i) the 1st year students (Entrepreneur Skills 1.1); ii) the 2nd year students (Information Systems 2.2); and iii) the 3rd year students (Business Analysis 3.1), all of whom were registered for different modules on different levels of the ICT Diploma programme. Table 3.3 shows how the quantitative participants were distributed in the study. Data were also collected (interviews and qualitative approach) from some of the lecturers presenting modules to the participating students. This triangulation of quantitative and qualitative data collection was done for authentication and validation of the research question.

Table 3.3: Descriptive sampling data

Participating Groups	2016 1st Semester		2016 2nd Semester
	Pre-test Collection	**Intervention**	**Post-test Collection**
First year students 1.1/1.2	1.1*		1.2*
Second year students 2.1/2.2	2.1**	2.1/2.2	2.2 **
Third year students 3.1/3.2	3.1***	3.1/3.2	3.2***
***1st** years are initially new from the high school into a tertiary setting during the pre-test study. No intervention was done with this group (**control group**). ****2nd** years have a year's tertiary exposure (pre-test and post-test) (**experimental group**). *****3rd** years have 2 years' tertiary exposure (pre-test and post-test) (**experimental group**).			

3.5.1.4 Data source (instrument) designs

The instruments for the data collection (Appendix A) consist of: i) demographic information; ii) CT assessment: and iii) game interest. These are now discussed in more detail.

i) Demographic information

The first part of the questionnaire contains the demographic information questions that seek to analyse the generation gap (age) among all participants and the type of matric or high school exit curriculum, and to categorise the participants according to their generic perceptions towards computers and games. The influence of the secondary school departure dimension can be vital in this study, since South Africa had numerous curriculum shifts in previous years (Mouton, Louw & Strydom, 2012). However, the participants in this study were taught the same curriculum and held the same high school exit rank. The last part on the demographic information is the arrangement of the students' academic year of study and the subjects registered for. This enables students not to be evaluated as individuals but as a group (class), categorised by the year level they were enrolled in (or the module registered for) during the study.

ii) CT assessment

The second section of in the questionnaire contains questions on CT skills, comprising of a sequence of categorised questions (according to the CT elements) and used to determine the level of CT skills of the participants. A test adapted from various critical thinkers and the *Critical Thinking Foundation* was used for student thinking skills alignment (Paul & Elder, 2002; Paul & Elder, 2008a).

iii) Game interest

The final section of the questionnaire contains questions that determine the game interests of students. This was completed to identify the gamers and the most played or preferred games among the students as well as their perceptions on game-based learning and gamification. Their interest in incorporating game-based learning or gamification into their syllabi was also tested.

The CT skills test questions were derived from various authors and adapted to suit this study (Paul & Elder, 2002; Newman, Webb & Cochrane, 2004). The test questions were guided using the *Critical Thinking Skills Success in 20 Minutes a Day* (Starkey, 2010) and the *Critical Thinking Foundation* skills test (Paul & Elder, 2002), and evaluated using Garrison's five stages (Newman, Webb & Cochrane, 2004). Group skills were evaluated instead of individual skills, where after the group (class) evaluation based on CT was used to categorise the questions. The main reason for choosing group rather than individual CT skills evaluation was the benefit of group collaboration in promoting CT skills.

Group collaboration enables communication among the group members (teamwork), who are exposed to different perspectives while clarifying their own. It further stimulates interest in the topic and enhances problem solving skills and critical thinking (Gitsaki et al., 2013). This adoption of the CT test was encouraged by the manner in which it was used to evaluate face-to-face and computer supported group learning. According to Newman, Webb and Cochrane (2004:4), the intention of evaluating CT skills in a group of students was to "look for signs of critical thinking in a social context", which was not the same intention in this study. Since the evaluation of CT skills for this study was done on face-to-face basis only, the Computer Supported Cooperative Learning (CSCL) evaluation was not included.

Surveys were used to collect the pre- and post-data from the students. The CT skills test is divided into five (5) elements, as follows:

i. **Problem identification:** The ability to identify a problem and significance
ii. **In-depth clarification:** The precise clarity and complexity of a problem
iii. **Judgement:** The logic and the ability to take a decision on the solution of the problem
iv. **Inference:** The fairness and the consideration of other views or opinions for problem resolution
v. **Strategy formation:** The ability to establish a plan for resolution (Newman, Webb & Cochrane, 2004:5)

3.5.1.5 Data collection

i) Population

A detailed explanation on how the study population was framed to produce a sample for the research is described in section 3.5.1.3.

ii) Unit of analysis

The unit of analysis is an entity that is being analysed in a study, as mentioned earlier (section 1.7.4). Therefore, the unit of analysis for this research is the CT skills of the participating students. According to Yin (2008:30), the definition of the unit of analysis is "primarily related to the research question and in that way should seek to favour the case, although this may not be a permanent closure". Baxter and Jack (2008) advocate that if the unit of analysis is not correctly identified, the rigor of the study is lost or not easily determined, especially when a researcher has more research questions to answer.

iii) Unit of observation

The units of observation are the participants in the study (the participating groups of students (1st, 2nd and 3rd years) and lecturers teaching the relevant modules in the ICT department.

iv) Implementation of the intervention

The students were divided into three different groups, separated by the year of study and the modules studied at different year levels (see section 3.5.1.1). The students were initially given a pre-test to determine the groups' (class/year level) CT level. The pre-test was then followed by the gamified presentation in the case of the experimental groups (2nd and 3rd years only). The intervention was supplementary to customary formal assessments. The motive for this was to neither interrupt the learning programme nor interfere with the students' assessments grading.

v) Collection of data: The process

Data collection was done in three stages using two different data collection techniques, of which two of the three phases were quantitative and the other one qualitative data collection. The three stages were as follows:

i. The first phase was the pre-test of which the data were collected from al the participating students.
ii. The second phase was the post-test which was also collected from all participants (experimental and control groups).
iii. The third phase was the qualitative interviews conducted by the researcher.

Figure 3.2 shows the precise construction of quantitative data collection using the same questionnaire for both CT skills tests (pre- and post-data). Quantitative data for both the pre- and post-tests were collected using the same questionnaire as an instrument during scheduled class times by relevant lecturers.

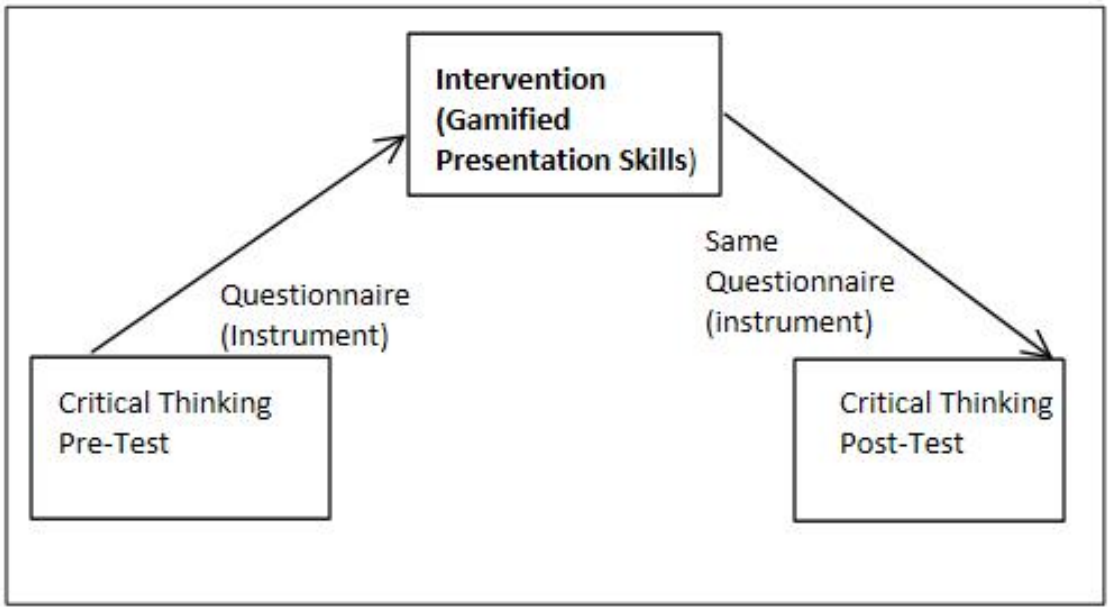

Figure 3.2: The structure of quantitative data collection for the study

The quantitative data (pre and post) were collected using a partially structured and unstructured questionnaire (Appendix A), which was administered to the participating students. For the data collection, pre- and post-quantitative surveys were given to three groups (with each class seen as a group and a year level of the Diploma) of students enrolled for different modules in the IT Diploma. The groups were purposively selected as the participants in the study. The (quantitative) pre-data were collected during the first semester of 2016 and the post-data during the final semester of 2016 (Table 3.3).

3.5.1.6 Data analysis

The nature of the study promoted the different data analytics methods, thus the quantitative data analysis was done using the Microsoft Excel 2013 package. Table 3.4 shows the intent to use the data collection technique (instrument), and how the instrument contributes to answering the research question. The CT skills questions were populated into the instrument as multiple-choice questions, with each question having single correct answer, as discussed earlier (section 3.5.1.4). This made it easier to evaluate the CT skills for comparing the students' responses to the correct answers provided. The collected data were analysed following the adopted work done by Newman, Webb and Cochrane (2004) for the evaluation of CT skills. The

formulated hypothesis based on the intervention in the study was tested and validated using the Microsoft Excel package.

Table 3.4: Data sets analysed in the study

Instrument	Purpose	Contribution to answering the research question
Questionnaire (Pre-test)	• To identify the CT skills obtained in high school (control group) • To determine the CT skills collected during tertiary education (experimental groups) • The students' perceptions of games and learning (their interest and learning)	• What thinking skills are to be considered for ICT teaching and learning to enhance critical thinking among students? • How can gamification engage the student in critical thinking? • How can students use gamification as a tool to improve their critical thinking skills?
Evaluated CT skills (Newman Method Rubric)	• To determine the CT level of each participating group	• What thinking skills are to be considered for ICT teaching and learning to enhance critical thinking among students?
Questionnaire (Post-test)	• To identify the CT skills possessed after a year of study at the university (experimental groups) • ompare the CT skills to the newly enrolled students (control group) • he students' perceptions of games and learning (their interest and learning)	• What thinking skills are to be considered for ICT teaching and learning to enhance critical thinking among students? • How can gamification engage the student in critical thinking? • How can students use gamification as a tool to improve their critical thinking skills?
Interviews	• To gather information on the perceptions (on CT and the use of games in education) of participants • To determine the agreement and disagreements on teaching and assessing critical thinking	• How can critical thinking be taught to ICT tertiary students? • ow can critical thinking be assessed at tertiary institutions?

3.5.1.7 Summary of quantitative data

The quantitative data were collected from the participating students in different year levels of study. A convenient non-random selection from the University system class lists of registered students were used for the target groups. The students were divided into three groups according to their year of study, the first years being the control group and the second and third year students were used as the experimental groups. CT skills were measured using a questionnaire (Appendix A, section B to F), where the CT skills questions (multiple-choice) were categorised according to CT skills elements detailed in section 3.5.1.4.

Data were analysed by looking at the correct answers of the multiple-choice questions against the incorrect responses given by the participants. The rubric (Appendix D) assisted in the categorisation and alignment of questions (in the questionnaire) to the CT skills elements. Several questions for each CT element represented a single point towards the skill, i.e. every correct response represented the existence or the acquisition of the CT skill element. The analysis of the CT skills was not done per student but as a group of students registered on the same level of study. This was done to evaluate the CT skills of a group of students on a specific year level of study, not the CT skills of a student (individual) registered on a certain level of study. The correct and incorrect answers were then analysed using Microsoft Excel Chi-square contingency tables to determine the significant differences between them. The results detailed in Table 4.6.

3.5.2 Interviews

The second phase of the mixed methods research involved interviews with the role players in student education at the UoT. The section is discussed the research strategy, data collection and data analysis.

3.5.2.1 Research strategy

Interviews were used for an in-depth understanding of the perceptions of lecturers on CT issues and challenges when educating the students. Lecturers (5) were selected using purposive, non-random, and convenient sampling. These five participants have been involved in curriculum development and teaching for many years. Table 3.5 shows the details of the interviewees involved in the study; three lecturers from the ICT department, one lecturer from the teaching foundation course for ICT students, and the final lecturer is from the Communication department, which is a servicing department to the ICT department. The lecturers were selected based on their interest in this specific research of gamification in education and they volunteered to be part of the study.

Table 3.5: Details of the lecturers (interviewees) participating in this study

Position	Teaching Experience	Level Teaching	Faculty and Department
Senior Lecturer	20+ years	1st & 2nd	Management Sciences, Auditing
Lecturer	3+ years	1st ,2nd, 3rd & BTech	Applied Sciences, ICT
Lecturer	10+ years	1st , 2nd & BTech	Applied Sciences, ICT
Lecturer	20+ years	1st , 2nd & Foundation Programme (IT)	Humanities, Communication (English)
Junior Lecturer	3+ years	1st ,2nd & 3rd	Applied Sciences, ICT

i) Unit of analysis

As mentioned in section 3.5.1.5, the unit of analysis is an entity being analysed during research. Therefore, the unit of analysis for this research is the CT skills of the participating students.

ii) Unit of observation

The units of observation are the participants who teach the modules in the ICT department. The units being measured are the CT skills of the participating students, therefore gamification elements in the ICT department were also analysed as an embedded part of the unit of analysis (Yin, 2013; Baxter & Jack, 2008).

3.5.2.2 Data collection

A semi-structured questionnaire interview guide (Appendix B) was used to guide the interviewer (researcher) throughout the interview process. All interviews were recorded after permission was obtained from the participants. Upon completion of the interviews, the recordings were transcribed (Appendix C) and mailed back to participants to validate the correctness of the transcription and the content in terms of the participants' intent behind the questions answered. The semi-structured questionnaire (Appendix B) for the interviews is divided into the following:

i) Demographic information

The first section of the interview questionnaire focused on demographic information such as gender, generation, and teaching experience in years. Although this study did not concentrate on these influences (gender, age and teaching experience), it was done based on the literature where differences between gender and the generational gap perceptions were shown.

ii) CT perceptions

The second part of the questionnaire was used to determine the individual perception on CT skills, whether the need or importance of CT for their students is acknowledged. Lecturers were also asked if CT skills are taught and assessed in the various modules that they offer to the ICT students.

iii) Views on games and learning

The lecturers were asked about their views on the appropriateness of games in a teaching and learning setting. They were also asked about their interpretations of integrating games into the teaching and learning, and specifically to their own subject modules.

3.6 Data analysis

According to Raddon (2010), data analysis can be a challenging and very complex execution. Quantitative data analysis represents the numerical data collected from the participants. The qualitative data analysis denotes non-numerical data that may include pictures and video clips. This study followed the sequential transformative design with a hypothetical perspective, aiming at giving priority to any ideology or framework formulated from the study (Creswell et al., 2003).

The qualitative data collected from the audio recordings of the interviews of the participating lecturers were transcribed and then firstly given to the participants to validate the content of the transcriptions, and secondly analysed using the categorising of data procedures (Saunders, Lewis & Thornhill, 2009). The transcripts have been analysed using codes, which included reading through each transcript to identify important common keywords and concepts. The criteria used in selecting the keywords and concepts were based on the frequency and the specificity of the responses. The initial results were communicated to the interviewees for credibility of the data interpreted by the researcher.

The scientifically analysed quantitative data and relevant patterns identified from the qualitative data analysis results are discussed in the Chapter Four.

3.7 Ethics

Research ethics explicitly involves the investigation of ethical matters that arise during research where people are involved as participants. According to Saunders, Lewis and Thornhill (2009), research ethics narrates questions about how one formulates and explains the research topic, how the research is planned and access is gained, the collection and analysis of data, and writing up the research in an ethical and accountable manner. Ethical clearance for the study was attained from the University involved in the study. No other ulterior motives influenced the findings in this research. Below are the ethical considerations that were reserved for this study.

i) Honesty

The research was conducted at a tertiary institution located in Gauteng where the researcher is employed. The researcher pledged to be honest to all the participants (colleagues and students), with no misrepresentation of the data and findings.

ii) Objectivity

The researcher pledged to do her utmost best to avoid self-deception, which could lead to biased data analysis and interpretation.

iii) Integrity

The researcher pledged to strive for consistency in her research methods, including data collection and analysis.

iv) Respect

The researcher pledged to respect the choice and decision of all her participants in the study, and that they would be treated fairly at all times.

v) Carefulness

The researcher pledged to critically examine her work and avoid careless errors and negligence in her research.

vi) Non-discrimination

The researcher pledged that discrimination based on any factors not related to the competency and integrity of the study as well as discrimination against colleagues and students would always be avoided, during and after this study.

vii) Confidentiality

The data collected and analysed would not be used as impairment to the repute of the institution involved in the study.

viii) Autonomy

- **Informed consent in assessments and provision of additional information:** All participants were informed of the purpose of the research. They were afforded an option to accept or reject participation in the study
- **Student disclosure of personal information:** The confidentiality and anonymity of all participants was at all times ensured, as they were promised before the study commenced

ix) Beneficence and non-malfeasance

The researcher pledged that care would be taken at all times to ensure that the data uncovered in this study do not pose any harm to the participants and the organisation involved. The participants will not be condemned based on the data gathered from the research.

x) Justice

They participants were selected and evaluated fairly and equally in accordance to benefits and risks experienced by all participants.

3.8 Summary

This chapter revised and described the research design applied in the study. The mixed methods research design was used to merge the qualitative and quantitative data collected from the participants, reinforced by a single interpretive, exploratory case study research strategy. The importance of determining and distinguishing the unit of analysis and the unit of observation for the study was observed. In-depth information about the data collection instruments, the adaption of the quantitative data source, selection of participants, as well as how data were analysed, was discussed.

Since this study involved the collection and analysis of qualitative and quantitative data, both the deductive and inductive research strategies were observed.

The data collection process was elaborated on, detailing the data collection instruments for the qualitative and quantitative data, the population and sampling, and the intervention procedure. The population was discussed by specifically indicating the manner in which the participants were sampled during the qualitative and quantitative phases of the study. The gamified intervention, detailed content and use were discussed. The final section of the chapter focused on the ethical considerations of the study, reserved and approved by the participating university on behalf of the students.

In Chapter Four, the analysed data and the findings of this research are presented and discussed.

CHAPTER FOUR: DATA ANALYSIS AND FINDINGS

4.1 Introduction

In this chapter the analysed data, research results, and findings are presented. The findings and results relate to the RQs posed in Chapter One. The aim of the research was to explore the effect of gamification on the critical thinking skills of ICT students. Given the assessment approaches and philosophies adopted from the literature review, the research is based on the assumption that the participants already possessed some level of CT skills before the intervention. The research questions are as follows:

RQ1: What are the challenges for ICT educators in teaching students to think critically?

- **SRQ 1.1:** What thinking skills are to be considered for ICT teaching and learning to enhance critical thinking among students?
- **SRQ 1.2:** How can critical thinking be taught to ICT tertiary students?
- **SRQ 1.3:** How can critical thinking be assessed at tertiary institutions?

RQ2: How can gamification contribute towards critical thinking skills?

- **SRQ 2.1:** How can gamification engage the student in critical thinking?
- **SRQ 2.2:** How can students use gamification as a tool to improve their critical thinking skills?

Because this research has adopted a mixed methods study, the two research questions were separated to represent the different views of the research. The **qualitative** approach answered both research questions (**RQ1** and **RQ2**), while the **quantitative** approach supported the study by demonstrating (statistically) the influence of the intervention (gamified presentations). The student questionnaire is provided in Appendix A, and the interview guide and transcripts are stated in Appendix B and Appendix C respectively. The results and findings in this chapter demonstrate the potential incorporation of CT philosophies and gamification practices into the ICT curriculum.

This chapter is outlined as follows: i) the case; ii) quantitative data analysis (results of CT skills per group of participants and the overall CT skills results; iii) qualitative data analysis results (from the five interviewees); iv) summary of findings and the

themes developed (qualitative); and v) summary of the combined data analysis results.

4.2 The case

A higher learning institution based in Gauteng was used as the case. The institution strives to implement better opportunities for innovation in technology to ensure that their product is compatible and prepared for industry. The study is based on a single sub-division in a faculty of the University. Three groups of students have been involved in the study as discussed earlier, of which two (2nd and 3rd year students) are experimental and one (1st year students) is the control group. The initial target was to collect and analyse data from 180 students; however, during the semester, eighteen (18) students were transferred to another campus and/or institutions due to non-compliance to the subject continuation policy. Twelve (12) questionnaires were excluded, as the participants failed to complete the questionnaires in full. The quantitative and qualitative data were collected from participating students (n=145) and lecturers (n=5). The detailed qualitative and the quantitative survey structures and designs are discussed in Chapter Three.

For the pre-test, data have been collected and analysed from 82 registered students across the three (3) different year levels of study (24 in the 1st year, 30 in the 2nd year, and 28 in the 3rd year). A decrease in the number of participants has been observed in the post-test, as data were collected and analysed from 63 registered students across the three (3) different year levels of study (23 in the 1st year, 26 in the 2nd year, and 14 in the 3rd year). Although this is not viewed as unusual, with convenient samples it may be influenced by factors such as economic issues and module prerequisites in the department. Moreover, some scholars caution against more ostensive threats such as maturation caused by the long period between the pre and post-test (Behar-Horenstein & Niu, 2011; Mogale, 2012). Semi-structured qualitative interviews were also conducted with ICT lecturers to explore the existence of CT skills in the content of their respective subject modules.

The respondents of the quantitative research are divided into three groups, according to their academic levels in years (1st, 2nd and 3rd years):

i. Entrepreneur Skills – 1st years (n=47)
ii. Information Systems – 2nd years (n=56)
iii. Business Analysis – 3rd years (n=42)

4.3 Data analysis results

This section is presented by first showing the quantitative results, followed by a discussion on the qualitative results.

4.3.1 Quantitative results

The structure of the results is as follows:

i. The demographic information
ii. Critical thinking assessment
iii. Game interest

4.3.2 Demographic statistics

Table 4.1 below outlines the participants' demographic information. More male than female students participated (which is not surprising), as there are usually more male than female students enrolled for the ICT Diploma.

Table 4.1: Outline of participants' demographic information

		Frequency		
		Pre	Post	Total
Gender	Male	53	33	86
	Female	29	30	59
High School Exit Level	1998 and earlier	1	0	1
	2004 and earlier	0	1	1
	2005 and later	14	7	21
	2010 and later	67	55	122
Generation	Gen Z	3	3	6
	Gen Y	79	59	138
	Gen X	0	1	1
	Baby boomers	0	0	0

The participants were mainly from the millennial generation, although a few were categorised as Generation Z. The inclusion of the generation gap (age) in the study was merely to analyse and categorise the generic perception towards computers and education among the participants. Many of the participants had similar knowledge and perceptions of computers and education.

4.3.3 Critical thinking results

Microsoft Excel 2013 has been used to determine whether the CT skills level before and after the gamification intervention differ among the students across the three selected groups (Entrepreneur Skills for 1st years, Information Systems for 2nd years,

and Business Analysis for 3rd years). The CT skills have been reported by the relevant lecturers (section 4.4.1.1) as the most crucial aspect in teaching and assessing ICT. This is supported by the literature study (section 2.2.4). The participating lecturers (interviewees) also stated that CT skills should be included in the syllabi of all the selected modules presented in the ICT Diploma used in this study.

4.3.4 Critical thinking statistical results

The student questionnaire consists of three sections (Appendix A):

i. Demographic information of the participant
ii. The CT test
iii. The game interest of the participant

The CT test is divided into five CT elements with 20 questions (Appendix A) distributed as follows:

- Problem identification (2 questions)
- In-depth clarification (4 questions)
- Inference (5 questions)
- Judgement (5 questions)
- Strategy formation (4 questions)

The results reported in the next sections are based on the correct responses versus the incorrect responses of the CT test questions before and after the intervention. Nineteen (19) questions were considered during the analysis; one question was excluded because of multiple answers. The results are per group (per question), not per student, as the test was anonymous.

After administering the CT pre-test, the gamification intervention was done with the two experimental groups (2nd years and 3rd years). The 1st year students were the control group. The intervention was then followed by administering the same CT post-test. The analysis is divided into five (5) segments:

- 1st year students (control group)
- 2nd year students (1st experimental group)
- 3rd year students (2nd experimental group)
- The overall CT skills for all interviewees
- The results of the CT skills elements

A contingency table displaying the frequency distribution of the CT skills values was used to demonstrate the Chi-square test result values. The Chi-square test was

used to determine the differences in the pre- and post-test results per CT skills standard admittance during the analysis and the results across the different years of study for all participating groups (control and experimental).

The following tests were done in order to test the hypothesis for this study:

Null Hypothesis H_0: there is no significant difference in the percentage correct CT scores (marks) between the CT pre-test and the CT post-test, formulated as:

- **H_0: $p_1 = p_2$**

Alternative H_1: there is a significant difference in the percentage correct CT scores (marks) between the CT pre-test and the CT post-test, formulated as:

- **H_1: $p_1 \neq p_2$**

4.3.4.1 First year students' pre- and post-test results for CT

CT Skills Finding 1: There is no change in the CT skills of the control group after the intervention

Table 4.2: Chi-square test sample statistics for 1st year students for all 19 questions

1st Years	Observed Values				Expected Values			
	Correct	Incorrect	Total		Correct	Incorrect	Total	p-value
Pre	135	321	456	**Pre**	147,06	308,94	456	0,08
Post	153	284	437	**Post**	140,94	296,06	437	
Total	**288**	**605**	**893**	**Total**	**288**	**605**	**893**	

Table 4.2 shows the observed and expected values for the number of correct and incorrect answers for the 19 CT questions, and their calculated 'p-values' (significance value). The significance value (p-value) signifies the acceptance or the rejection of the hypothesis. A p-value greater than 0,05 indicates a weak evidence against the null hypothesis, so the null hypothesis **cannot** be rejected. From the Chi-square test in Table 4.2 above, the p-value is above 0.05 (p = 0,08); thus, the null hypothesis is accepted for the 1st year students. The **CT skills for the 1st year participants (students) before the intervention is equal (similar) to the CT skills after the intervention.** The conclusion here is that there is no improvement in the CT of 1st year students.

4.3.4.2 Second year students' pre- and post-test results for CT

CT Skills Finding 2: There is no change in the CT skills of the 2nd year experimental group after the intervention

Table 4.3: Chi-square test sample statistics test for 2nd year students for all 19 questions

2nd Years	Observed values				Expected values			
	Correct	Incorrect	Total		Correct	Incorrect	Total	p-value
Pre	191	379	570	Pre	196,26	373,74	570	0,5
Post	175	318	493	Post	169,74	323,26	493	
Total	366	697	1063	Total	366	697	1063	

Table 4.3 shows the observed and expected values for the correct and incorrect answers for the 19 CT questions, and their calculated 'p-values; (significance value). The significance value (p-value) signifies the acceptance or the rejection of the hypothesis. A p-value greater than 0,05 indicates a weaker evidence for the null hypothesis, and therefore **acceptance** of the null hypothesis. From the Chi-square test in Table 4.3 above, the p-value is higher than 0.05 (p = 0,5); thus, the null hypothesis is accepted for 2nd year students. The **CT skills before the intervention is similar (equal) to the CT skills after the intervention.** This means that there is no enough evidence of improvement in the CT skills for the 2nd year students. This group is one of the experimental groups; consequently, the conclusion is unfavourable for the study.

4.3.4.3 Third year students' pre- and post-test results for CT

CT Skills Finding 3: There is a positive change in the CT skills for the 3rd year experimental group after the intervention

Table 4.4: Chi-square test sample statistics for 3rd year students for all 19 questions

3rd Years	Observed values				Expected values			
	Correct	Incorrect	Total		Correct	Incorrect	Total	p-value
Pre	239	293	532	Pre	253,33	278,67	532	0,03
Post	141	125	266	Post	126,67	139,33	266	
Total	380	418	798	Total	380	418	798	

Table 4.4 shows the observed and expected values for the correct and incorrect answers for the CT questions, and their calculated 'p-values' (significance value). The significance value (p-value) signifies the acceptance or the rejection of the

hypothesis. A p-value lesser than 0,05 indicates a strong evidence against the null hypothesis, resulting in the **rejection** of the null hypothesis. From the Chi-square test in Table 4.4 above, the p-value is below 0.05 (p = 0,03); thus, the null hypothesis is rejected for the 3rd year students. In conclusion, **there is a significant improvement in the CT of the 3rd year students**. This means that the null hypothesis (H_0) is **rejected** at 5% level of significance, and an alternative hypothesis is accepted; i.e. The **CT skills before the intervention are NOT equal to the CT skills after the intervention.** This group is one of the experimental groups; consequently, the conclusion here is favourable for the study.

4.3.4.4 Overall participants' pre- and post-test results for CT

CT Skills Finding 4: There is no change in the CT skills of all the interviewees after the intervention

Table 4.5: Chi-square test sample statistics for all participating groups (control and experimental)

All Students	Observed values				Expected values			
	Correct	Incorrect	Total		Correct	Incorrect	Total	p-value
Pre	565	993	1558	Pre	584,1	973,04	1558	0,11
Post	469	727	1196	Post	449,04	746,1	1196	
Total	1034	1720	2754	Total	288	605	2754	

Table 4.5 shows the observed and expected values for the correct and incorrect answers for the CT questions, and their calculated 'p-values' (significance value). The significance value (p-value) signifies the acceptance or the rejection of the hypothesis ($\mathbf{H_0}$ against $\mathbf{H_1}$). A p-value greater than 0,05 indicates a weaker evidence for the hypothesis, so the null hypothesis is **accepted**.

From the Chi-square test in Table 4.5 above, the p-value is higher than 0.05 (p = 0,11); thus, the null hypothesis is accepted, i.e. the **CT skills before the intervention has not changed from the CT skills after the intervention.** No significant difference was observed between the CT skills before and after the intervention when all the participating groups are combined. This conclusion is also supported by Table 4.6, which shows all the p-values for the CT skills elements against the year of study enrolled by the students. There is no change in CT skills elements when observing all the interviewees.

- $\mathbf{H_0}$, the students' CT skills are independent upon their enrolled year of study
- $\mathbf{H_1}$, the students' CT skills are dependent upon their enrolled year of study

4.3.4.5 The interaction between the year of study and the CT elements

CT Skills Finding 5: There is no significant difference in the CT skills elements of all interviewees

The purpose for this test was to determine if there is any significant difference in the CT skills of the participants across the different years of study. The Chi-square p-value test (Table 4.6) was conducted and the results of both tests (pre and post) were calculated to establish if there is any change in the CT skills. This test was done based on the following assumptions:

i. The dependent variable (learning) is continuous, as the learning is based on the syllabi that promote or advocate the CT skills being observed or measured.

ii. The independent variable is tested on at least two or more groups. CT for the recent study was divided into five different elements to determine the most and least effective skills taught to the participants. Moreover, there are three different groups shown in the study.

iii. The independent variable was observed, as the participants were grouped in terms of modules that are pre-requisites to each other. It can be confirmed that different participants were assigned to different groups; **it was thus not possible to have the same participant in more than one group** (year of study).

Table 4.6: Chi-square test sample statistics for CT skills of all participating groups (control & experimental)

CT Skills Elements	1st year p-value	2nd year p-value	3rd year p-value	Overall p-value
PI1	0,302	0,712	0,006	0,139
PI2	0,464	0,353	0,186	0,715
IDC2	0,045	0,799	0,072	0,071
IDC3	0,932	0,078	0,827	0,136
IDC4	0,471	0,206	0,345	0,197
Inference 1	0,352	0,757	0,374	0,460
Inference 2	0,036	0,235	0,350	0,791
Inference 3	0,831	0,690	0,186	0,641
Inference 4	0,013	0,969	0,064	0,459
Inference 5	0,400	0,839	1,000	0,893
Judgement 1	0,312	0,950	0,092	0,659
Judgement 2	0,312	0,505	0,306	0,386
Judgement 3	0,177	0,757	0,306	0,316
Judgement 4	0,050	0,565	0,047	0,007
Judgement 5	0,085	0,026	0,661	0,024

SF1	0,285	0,983	0,608	0,220
SF2	0,975	0,034	0,827	0,343
SF3	0,133	0,873	0,469	0,781
SF4	0,108	0,072	1,000	0,100

In Table 4.6, the codes for the five (5) CT skills elements (Appendix A) are explained as follows:

i. PI = Problem identification (2 questions)
ii. IDC = In-depth clarification (4 questions)
iii. Inference (5 questions)
iv. Judgement (5 questions)
v. SF = Strategy formation (4 questions)

Table 4.6 denotes the primary CT skills elements which had a significant (p-value ≤ 0.05) difference (indicated by grey shading) from the pre- to post-test during the analysis process. Surprisingly, the 1st year students (control group) had more significant individual elements (IDC, Inference, Judgement, and SF) than the other years of study; yet, the total CT skills showed an insignificant (p-value ≥ 0.05) difference. Similarly, the 2nd and 3rd year students (experimental groups) have different results but an equal number of significant CT skills elements. However, *judgement* is the only CT skills element showing an improvement from pre- to post results on the overall student CT skills evaluated.

4.3.5 Games results

CT Skills Finding 6: Gaming assists in enabling deeper concentration, thereby enhancing CT skills

The *gaming attention* of the students had a 2% change (from 74% - 76%) from the pre- to the post-test. Of all 145 pre-and post-test results on gaming interests, 75% of the participants on average remained interested in playing games, especially those who regarded themselves as gamers.

Figure 4.1 shows the types of games preferred by the participants. Most participants (27 out of 63) preferred digital video games (43%) to other games such as board games (11) and normal sport (5). However, an increase of 11% on the *gamification understanding*, the *perceptions on classroom conduct,* and the *teaching and learning environment* were observed.

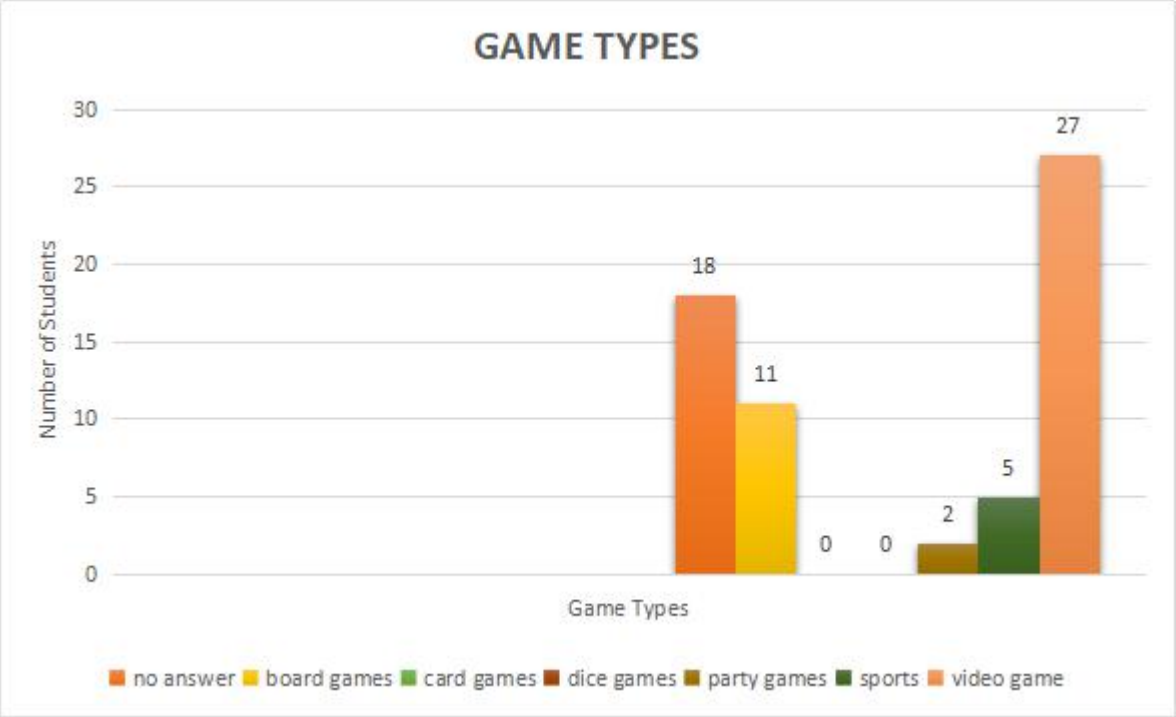

Figure 4.1: The participants' game type preferences

4.3.6 Summary of quantitative results

The aim of this study was to explore the effect of gamification on the critical thinking skills of ICT students. The questionnaires used were analysed using Microsoft Excel 2013. The effect of gamified techniques on the overall CT skills of a group of students was explored in this study, hence none of the CT constituencies (logical and analytical thinking skills) were individually analysed, and the analysis was not done for individual students. Table 4.7 shows the simplified and summarised data with the research question and findings.

- The pre- and post-test results for the CT skills of all the groups had no significant improvement. The post-test results of the 1st, 2nd and 3rd year students differed significantly
- The results of the 3rd year (experimental) group improved significantly from the pre- to the post-test
- The intervention did not assist in improving the CT skills of the 2nd year group

Table 4.7: Summary of research questions and quantitative findings

Research Questions (RQ)	Sub-Research Questions (SRQ)	Findings
RQ2 How can gamification contribute towards	**SRQ 2.1** How can gamification engage the student	**CT Skills Finding 1:** There is no change in the CT skills of the control group after the intervention **CT Skills Finding 2:** There is no change in the CT

critical thinking skills?	in critical thinking?	skills for the 2nd year experimental group after the intervention **CT Skills Finding 3:** There is a positive change in the CT skills for the 3rd year experimental group after the intervention **CT Skills Finding 4:** There is no change in the CT skills of all the interviewees after the intervention **CT Skills Finding 5:** There is no significant difference in the CT skills elements of all interviewees
	SRQ 2.2 How can students use gamification as a tool to improve their critical thinking skills?	**CT Skills Finding 6:** Gaming assists in enabling deeper concentration, thereby enhancing CT skills

4.4 Qualitative results

The findings of the interviews are presented in this section. The structure for this section is as follows: i) demographic information; ii) critical thinking teaching and assessment; and iii) gamification experiences. Interviews have been conducted with five (5) lecturers teaching different modules in ICT to the students involved in the study. Their teaching experience and job profiles (demographic information) are presented in Table 4.8.

Table 4.8: Outline of lecturing expertise

Generation	Gender	Teaching Experience	Level Teaching	Subjects Taught
Baby Boomer (2)	F	20+ years	1st & 2nd	Entrepreneur Skills and Communication Skills (English)
Gen Y (2)	M	3+ years	1st, 2nd & 3rd	Information Systems and Business Analysis
Traditionalist (1)	M	10+ years	1st & 2nd	Web Management and Programming

4.4.1 Interviews

This section describes the results obtained from the interviews. The interviews have been conducted based on the research questions, and the findings of the interviews were guided by the main research questions of the study. Findings are presented at the end of each question.

RQ1: What are the challenges for ICT educators in teaching students to think critically?

4.4.1.1 Sub-research question 1.1

SRQ 1.1: What thinking skills are to be considered for ICT teaching and learning to enhance critical thinking among students?

IQ 1.1.1: Do you think critical thinking is important for your students? How do you feel about critical thinking?

All the interviewees (Is) advocated the need and importance of CT skills. Different views on how the importance of CT skills will benefit the students have been observed. The views include an increase in knowledge, thereby allowing the students to display deep thinking at school level, and the necessity of applying CT skills in the workplace. Interviewee 1 (I1) said: “Absolutely vital… They need to be able to think in a critical fashion because very soon they will, are going to be out in the workplace and to assess situations that they are in, in a critical way” (Appendix C; Interviewee 1).

I3 stated that, “Yes, it is very important. Why? Because the students are actually taught to go and solve real life problems so they need to have that CT to be able to solve those problems that are out of here” (Appendix C, Interviewee 3). I4 focused on the present need and the application of CT that improves the students thinking, stating the following: “Yes, I think it is important because students are supposed to think critically so that they can support their statements and be independent” (Appendix C, Interviewee 4).

Finding 1: CT is an important skill

Finding 2: CT is an important skill that is not just applicable when studying; it is also important in the workplace

IQ 1.1.2: Do you think your students are logical thinkers?

Two of the five candidates (I2, I4) perceived their students to be logical thinkers, but the other three did not feel comfortable labelling them as such. According to I2 and I4, logical thinking can only be shown through tasks given to students; it is therefore the responsibility of the facilitator to encourage these skills.

I2 argued that, “This can only show if you give them a chance to show it, but I cannot really say ehh…they are logical thinkers or not logical thinkers but when you give them a task, then from that task you are able to tell whether they were thinking” (Appendix C, Interviewee 4).

I4 stated the following:

> "I think it differs from group to group, there are those types that have heretical skills or [are] very bright; there are those types that are average students. I will say it differs from group to group, maybe because on how I enhance the critical thinking. I think it's also being governed by other subjects are they actually being taught – how to think logically or just to pass so it's not a one man's job, it depends on [the] role of other educators" (Appendix C, Interviewee 4).

I5 opined that CT and logical thinking go hand-in-hand: "Logical thinking, I think is a critical thinking with the fact if you cannot think logically, you cannot be critical. I think they go hand-in-hand….yes" (Appendix C, Interviewee 5).

Finding 3: Students have to be taught to think logically

Finding 4: Logical thinkers are better critical thinkers

IQ 1.1.3: Do you think your students possess any critical thinking skills?

Three of the interviewees (I2, I3, I5) agreed that as students enter tertiary education, they possess a certain level of critical skills attained throughout their educational years. According to I1 and I4, the CT skills level of students can deviate because some may have a higher or lower CT level. Notwithstanding the contrast in the interviewees' opinions on the role that students play in improving their CT skills, the interviewees agreed that clear and consistent guidance by the educator is the key to an improved CT approach. I3 said that, "Yes, I think they do; it is up to us to show them ways of how they can become more critical thinkers because they possess something, they come with something when they come to universities" (Appendix C, Interviewee 3). This is supported by I5: "Yes, by the virtue of the fact that they have chosen to do IT, to me they saw it was on demand and they wanted to prove their critical thinking skills; yes, they come with their own but it needs to be guided" (Appendix C, Interviewee 5).

Finding 5: Students do possess a certain level of CT skills when entering the university

Finding 6: CT skills have to be guided, refined, and improved during teaching and learning

IQ 1.1.4: What thinking skills are to be considered for ICT teaching and learning to enhance critical thinking among students?

Three of the interviewees (I1, I3, I4) are ICT lecturers and two (I2, I5) are lecturers teaching supporting modules (Communication Skills and Entrepreneur Skills), which

are incorporated in the ICT Diploma. Logical and analytical thinking skills are the most referred to skills that are considered to improve CT skills among ICT students. I5 said the following: “Yes, students need to be taught to think critically in order to solve problems independently and be responsible for their own education” (Appendix C, Interviewee 5). I1 stated that, “One of the thinking skills that seem to need a lot of attention is ahh…conceptualising ideas and then logically trying to formulate a system out of those ideas, so logic to build up and then also conceptualising ideas into a composite concept you know, like ehh…a whole” (Appendix C, Interviewee 1).

Finding 7: CT skills enable problem-solving skills

Finding 8: There is lack of logical and analytical thinking skills among the students

4.4.1.2 Sub-research question 1.2

SRQ 1.2: How can critical thinking be taught to ICT tertiary students?

IQ 1.2.1: Do you think lecturers are supposed to teach students to think critically? Also, do you think students need to be taught to think critically?

All the interviewees agreed that developing CT skills is important and needs to be integrated in every learning module used in teaching and learning, not only for the ICT students, but also for all the other students in a tertiary institution. According to I2, one cannot intentionally plan to teach CT; rather give tasks to students that will allow and encourage students to think critically. However, I5 said: “Yes, I think critical thinking must be taught…” (Appendix C, Interviewee 5).

I4 stated:

> “The case study approach of IS, I will say that it is the one that teaches the students how to think because that is where they are shown the real life experience that they have to analyse; even BA itself, it requires them to think critically because they are presented with scenarios. Otherwise, the rest of the subjects, I may not be sure about those in programming…I have not taken programming but I know it teaches them to think critically, must be how to think critically, I think importantly they will” (Appendix C, Interviewee 4).

Finding 9: CT skills have to be taught for students to think critically

Finding 10: Lecturers have different approaches to the development of CT skills for students

IQ 1.2.2: Would you say that your subject content encourages you to teach critical thinking to your students?

All the interviewees agreed that some segment (if not all) in the syllabus teaches CT skills to the students. I2 also mentioned that there is an indirect way that needs interpretation, which can then be translated as CT. All the interviewees were comfortable that the CT components are in fact integrated in the learning modules they are responsible to teach.

Finding 11: CT skills are assimilated in all ICT modules taught at diploma level

4.4.1.3 Sub-research question 1.3

SRQ 1.3: How can critical thinking skills be assessed at tertiary institutions?

IQ 1.3.1: How will you assess CT skills resourcefully? If yes, how do you make sure that it is assessed resourcefully?

Since the interviewees agreed that they do teach CT, the assessment of CT is imperative in determining the depth of the knowledge acquired. The interviewees indicated that the resources (such as the use of the Internet) and new innovative ways (not in the usual prescribed textbooks) applied to source information, are the tools that will enable efficient results if used in assessments.

I3 argued that:

> "In terms of assessment of critical thinking, it is the way you set your questions; you must make sure that you allow the students to apply their minds unlike asking questions such as "define", where you expect the students to recap or memorise to tell you exactly what the textbook say[s], but then they need to apply whatever content they have learned to a specific situation in a specific case study – then they apply what they have learned" (Appendix C, Interviewee 3).

Finding 12: CT skills can be effectively assessed using deep thinking assessment methods

IQ 1.3.2: Do lecturers have an input in subject content and syllabi that they present to their students?

The interviewees are all working at a delivery site of the UoT (the case), and most of the syllabus and course outline decisions are made on the main campus. This poses a challenge to most of the lecturers, as some are allowed a minimal contribution to the syllabi design in the modules that the lecturers are teaching. Although most of the information is centralised, the final work is done on the main campus. I2 said: "We only help them, a few, I would say in communication, so much of the work is

centralised, but ahh…here and there they ask like individuals to suggest maybe exercises or questions for a semester test, so in a way, yes, though it is not in your name" (Appendix C, Interviewee 2).

Finding 13: Lecturers are not given enough opportunities to contribute towards the formation of syllabi and subject content programme outlines

IQ 1.3.3: Are you responsible for the subject content programme outline? If not, are you involved in the formation of the syllabi?

The lectures are merely afforded an insignificant opportunity (if any) to provide input into the programme outline and syllabi. I3 said: "Hmm, no, normally there's a subject head and they ask like what inputs we have, they send us like hmmm syllabus and communicate via emails" (Appendix C, Interviewee 3). This seems to be working fine in the ICT departments, but the same cannot necessarily be said about the others. According to I5, "I am not allowed, I just get a syllabus as it is and therefore transfer it to the students of which… ehh I see that as not being correct because I am always with these students, every day, I see the students' needs. I think I should have an input" (Appendix C, Interviewee 5).

Finding 14: Subject content programme plans are compiled by subject heads and then communicated to the subject presenters

IQ 1.3.4: Are you responsible for assessing your students? If not, are you informed on how it is done?

Although most of the interviewees (I2, I3, I5) are not responsible for assessing the modules they teach, they are allowed to contribute to semester tests and sometimes to the final examination. I1 stated: "Very little, it's all dictated by main campus" (Appendix C, Interviewee 1).

Finding 15: Not all lecturers presenting the module are allowed to compile assessments for their students

RQ2: How can gamification contribute towards critical thinking skills?

4.4.1.4 Sub-research question 2.1

SRQ 2.1: How can gamification engage the student in critical thinking?

IQ 2.1.1: How do you feel about gaming?

Gaming is described as a tool for teaching. Gaming is viewed to be a stress reliever and allows for unobserved knowledge acquisition. Of the five interviewees, only one (I4) showed familiarity and being comfortable with games. I1 (from the traditionalist generation) said:

> "Ehh I am very open to it, I think it's great. It can be a great teacher, the problem that I personally have found and that is so to speak not for me, is the fact that when I go to the gaming situation on a computer, I get lost. It is not user friendly. I don't know why the heck they are trying to do what they try to do, ehh… but I do believe that there can be a hang of a lot of thinking in it" (Appendix C, Interviewee 1).

I2 from the baby boomer generation expressed her unfamiliarity with games through the following statement: "You know when you talk about games they just state about non-educational games, yes, so sometimes now because you teach ICT, I am not very sure and ahh…not very familiar with the games that you can use in ICT that can benefit students, you know" (Appendix C, Interviewee 2). I3, from the Gen Y generation, however said the following: "Gaming in general is fine because it allows a number of people to reduce stress levels…you know, because it takes you out of whatever environment that it takes you, somewhere else where you are free, you know, if you play a game you can lose, you can win. It changes your mindset, you know, so they do say gaming reduces the stress levels" (Appendix C, Interviewee 3).

Finding 16: Most lecturers are not interested or familiar with games

IQ 2.1.2: Do you think gaming is important for recent generation ICT students?

All the interviewees agreed that games are important, as the students are more drawn to gaming. The interviewees also added that although gaming might not benefit all the students, it could be used as another form of teaching and learning style. I1 said: "Yes, no doubt… Ehh because somehow they seem very attracted to it and almost without themselves knowing it; they are learning certain skills of moving in certain directions and even in certain thinking directions" (Appendix C, Interviewee 1). I3 also stated: "It changes your mindset, you know, so they do say gaming reduces the stress levels" (Appendix C, Interviewee 3).

I2 had this to say: "Hmm yah…I don't think there is much difference when it comes to the courses that the students are taking because the students that we have now, they are all, you know, into new technology, they are digital natives, they are born during this period where you know…of technology" (Appendix C, Interviewee 2). I4 said: "To play games? Yes, it is important because when they play games they

concentrate more because you've got a target that you want to achieve" (Appendix C, Interviewee 4).

Finding 17: Playing games is important for students

Finding 18: Gaming reduces stress levels

IQ 2.1.3: In your opinion, are there any cognitive benefits of gaming from gamers?

All the interviewees maintained that CT skills are acquired through game play. I3 and I4 supported each other on the effects of gaming. I4 said that,

> "Yes. Why am I saying so? Because when you are gaming you need to think ahead, you need to think fast and those are in fact, mainly thinking fast actually trains your brain just like me emotionally, I am a bad looser. But gaming itself, it increases your thinking capacity" (Appendix C, Interviewee 4).

I4 further mentioned that, "To play games? Yes, it is important because when they play games they concentrate more because you've got a target that you want to achieve" (Appendix C, Interviewee 4). I5 opined that, "Cognitive has to do with thinking skills yes, since they are unique I think there is something that maybe three out of ten will benefit from that" (Appendix C, Interviewee 5).

Finding 19: Gaming can sharpen the mind and enable deeper concentration

4.4.1.5 Sub-research question 2.2

SRQ 2.2: How can students use gamification as a tool to improve their critical thinking skills?

IQ 2.2.1: Do you think gaming can be incorporated into your subject curriculum?

Various comments were received from the interviewees. Firstly, it was stated that gaming might not work for all the students; secondly, the interviewees felt that gaming could lead to additional work for the lecturers unless more assistance is provided; and thirdly, the resources could be a drawback for incorporating games in the subject curriculum. All the interviewees agreed that it is possible to implement gaming, and that it would definitely be a benefit.

Finding 20: Gamification can be implemented in any subject curriculum with the understanding of game elements

IQ 2.2.2: Are there any interesting approaches you can suggest to enable teaching critical thinking skills efficiently?

The interviewees emphasised that the best approach to teaching and learning is learner-centred methods. Exemplifying how the gamified curriculum may benefit students, I1, I3 and I4 respectively commented as follows:

> "What we need there is also to put an example on turning it in a game where, ehh… oh, ahh, gosh, things like ehh… rolling the dice and then professing certain moves, and some moves might need to be more than four or less than two or whatever. We need to get a game aspect into it and not just always copy the business situation" (Appendix C, Interviewee 1).

> "Hmmm when I look at the way we assess our students, maybe it is also important to put, you know, where you put something like a game as part of the question already. When they look at that question paper, there being a game already drags the attention so I think maybe gamification is the way to include maybe as part of the assessment" (Appendix C, Interviewee 3).

> "I think the best way is let's give them real life experiences. If [it] to be through the game, let it be based on real life experiences so in that way education is taken out of the classroom into the community; then that way [it] will increase critical thinking because in that way you are encountering the real problem" (Appendix C, Interviewee 4).

Finding 21: Gamification can be used to teach CT

4.5 Summary of findings and themes developed

The transcripts have been analysed using codes and reading through each transcript to identify important common keywords and concepts. The criteria used in selecting the keywords and concepts were based on the frequency and specificity of the responses. The initial results have been communicated to the interviewees in order to assure the credibility of the researcher's interpretation of the responses.

The findings and research questions are presented in Table 4.9 and Table 4.10.
The merged results from the data analysis are categorised and presented as: i) New knowledge base and teaching skill; ii) Subject-based curriculum; and iii) Assessment rules.

Table 4.9: Research questions, sub-research questions, and findings

SRQs	Findings
RQ1: What are the challenges for ICT educators in teaching students to think critically?	
SRQ 1.1 What thinking skills are to be considered for ICT teaching and learning to enhance critical thinking among students?	**Finding 1:** CT is an important skill **Finding 2:** CT is an important skill that is not just applicable when studying; it is also important in the workplace **Finding 3:** Students have to be taught to think logically **Finding 4:** Logical thinkers are better Critical thinkers
SRQ 1.2 How can critical thinking be taught to ICT tertiary students?	**Finding 5:** Students do possess a certain level of CT skills when entering the university **Finding 6:** CT skills have to be guided, refined, and improved during teaching and learning **Finding 7:** CT skills enable problem-solving skills **Finding 8:** There is lack of logical and analytical thinking skills among the students **Finding 9:** CT skills have to be taught for students to think critically **Finding 10:** Lecturers have different approaches to the development of CT skills for students **Finding 11:** CT skills are assimilated in all ICT modules taught at diploma level
SRQ 1.3 How can critical thinking be assessed at tertiary institutions?	**Finding 12:** CT skills can be effectively assessed using deep thinking assessment methods **Finding 13:** Lecturers are not given enough opportunities to contribute towards the formation of syllabi and subject content programme outlines **Finding 14:** Subject content programme plans are compiled by subject heads and then communicated to the subject presenters **Finding 15:** Not all lecturers presenting the module are allowed to compile assessments for their students
RQ2: How can gamification contribute towards critical thinking skills?	
SRQ 2.1 How can gamification engage the student in critical thinking?	**Finding 16:** Most lecturers are not interested or familiar with games **Finding 17:** Playing games is important for students **Finding 18:** Gaming reduces stress levels **Finding 19:** Gaming can sharpen the mind and enable deeper concentration
SRQ 2.2 How can students use gamification as a tool to improve their critical thinking skills?	**Finding 20**: Gamification can be implemented in any subject curriculum with the understanding of game elements **Finding 21:** Gamification can be used to teach CT

Table 4.10: Summary of research questions, findings and the themes developed

SRQs	Findings	Themes
RQ1: What are the challenges for ICT educators in teaching students to think critically?		
SRQ 1.1 What thinking skills are to be considered for ICT teaching and learning to enhance critical thinking among students?	**Finding 1:** CT is an important skill **Finding 2:** CT is an important skill that is not just applicable when studying; it is also important in the workplace **Finding 3:** Students have to be taught to think logically **Finding 4:** Logical thinkers are better Critical thinkers	New knowledge base and teaching skill
SRQ 1.2 How can critical thinking be taught to ICT tertiary students?	**Finding 5:** Students do possess a certain level of CT skills when entering the university **Finding 6:** CT skills have to be guided, refined, and improved during teaching and learning **Finding 7:** CT skills enable problem-solving skills **Finding 8:** There is lack of logical and analytical thinking skills among the students **Finding 9:** CT skills have to be taught for students to think critically **Finding 10:** Lecturers have different approaches to the development of CT skills for students **Finding 11:** CT skills are assimilated in all ICT modules taught at diploma level	Subject-based curriculum
SRQ 1.3 How can critical thinking be assessed at tertiary institutions	**Finding 12:** CT skills can be effectively assessed using deep thinking assessment methods **Finding 13:** Lecturers are not given enough opportunities to contribute towards the formation of syllabi and subject content programme outlines **Finding 14:** Subject content programme plans are compiled by subject heads and then communicated to the subject presenters **Finding 15:** Not all lecturers presenting the module are allowed to compile assessments for their students	Assessment rules
RQ2: How can gamification contribute towards critical thinking skills?		
SRQ 2.1 How can gamification engage the student in critical thinking?	**Finding 16:** Most lecturers are not interested or familiar with games **Finding 17:** Playing games is important for students **Finding 18:** Gaming reduces stress levels **Finding 19:** Gaming can sharpen the mind and enable deeper concentration	New knowledge base and teaching skill
SRQ 2.2 How can students use gamification as a tool to improve their critical thinking skills?	**Finding 20:** Gamification can be implemented in any subject curriculum with the understanding of game elements **Finding 21:** Gamification can be used to teach CT	Subject-based curriculum

Table 4.11 denotes the developed themes, interpretations, and results.

Table 4.11: Themes, interpretations and the results

Themes	Interpretation	Results
New knowledge base and teaching skill	It is the ability of an educator to understand, process, and evaluate new knowledge relevant for teaching, with the intention to advance the teaching quality, which may be used to determine the gains in student achievement or to improve student outcomes.	CT skills are important for lifelong learning. Deep thinking, logical thinking, and analytical thinking are elements of CT. CT is a skill that can be taught and developed throughout one's educational years. With the understanding of game elements, gamification can be applied to any subject module.
Assessment rules	Assessment rules are practices regulated to establish a clear guideline to ensure the alignment of assessment strategies that effectively support the achievement of intended learning outcomes.	CT is a skill that can be evaluated to ensure the development of this skill.
Subject-based curriculum	A clear definition of the curriculum vision that provides knowledge and skills such as learning needs and an understanding of the limitations of a subject in the curriculum.	Games can be used to enhance the deep thinking skills.

4.6 Summary of combined (qualitative and quantitative) findings and themes

Table 4.12 denotes the joint summary of the qualitative and quantitative study results. The researcher adopted a mixed methods study, where the qualitative study results were used to support, triangulate, and validate the quantitative part of the study. The grey areas on the table indicate the quantitative findings (the questionnaire findings) inclusions of the mixed methods study, which is reinforced by the qualitative findings (interviews findings).

Table 4.12: Summary of combined (quantitative and qualitative) RQs, findings and themes

SRQs	Findings	Themes
RQ1: What are the challenges for ICT educators in teaching students to think critically?		
SRQ 1.1 What thinking skills are to be considered for ICT teaching and learning to enhance critical thinking among students?	**Finding 1:** CT is an important skill **Finding 2:** CT is an important skill that is not just applicable when studying; it is also important in the workplace **Finding 3:** Students have to be taught to think logically **Finding 4:** Logical thinkers are better Critical thinkers CT skills elements (problem identification, in-depth clarification, inference, judgement, strategy formation) used during the test enabled the categorisation of necessary skills needed to evaluate the CT skills among participating students.	*New knowledge base and teaching skill*

SRQs	Findings	Themes
SRQ 1.2 How can critical thinking be taught to ICT tertiary students?	**Finding 5:** Students do possess a certain level of CT skills when entering the university **Finding 6:** CT skills have to be guided, refined, and improved during teaching and learning **Finding 7:** CT skills enable problem-solving skills **Finding 8:** There is lack of logical and analytical thinking skills among the students **Finding 9:** CT skills have to be taught for students to think critically **Finding 10:** Lecturers have different approaches to the development of CT skills for students **Finding 11:** CT skills are assimilated in all ICT modules taught at diploma level	*Subject-based curriculum*
SRQ 1.3 How can critical thinking be assessed at tertiary institutions?	**Finding 12:** CT skills can be effectively assessed using deep thinking assessment methods **Finding 13:** Lecturers are not given enough opportunities to contribute towards the formation of syllabi and subject content programme outlines **Finding 14:** Subject content programme plans are compiled by subject heads and then communicated to the subject presenters **Finding 15:** Not all lecturers presenting the module are allowed to compile assessments for their students CT skills are normally used during the assessment of modules to test deep thinking skills	*Assessment rules*
RQ2: How can gamification contribute towards critical thinking skills?		
SRQ 2.1 How can gamification engage the student in critical thinking?	**CT Skills Finding 6:** Gaming assists in enabling deeper concentration, thereby enhancing CT skills (Quantitative) **Finding 16:** Most lecturers are not interested or familiar with games **Finding 17:** Playing games is important for students **Finding 18:** Gaming reduces stress levels **Finding 19:** Gaming can sharpen the mind and enable deeper concentration The intervention (Gamified Presentation Skills) used as an assessment	*New knowledge base and teaching skill*
SRQ 2.2 How can students use gamification as a tool to improve their critical thinking skills?	**Finding 20:** Gamification can be implemented in any subject curriculum with the understanding of game elements **Finding 21:** Gamification can be used to teach CT The intervention (Gamified Presentation Skills) used as an assessment	*Subject-based curriculum*

4.7 Summary

This chapter discussed the quantitative results collected from the questionnaires as well as the qualitative findings collected from the interviews. The quantitative results were validated using Microsoft Excel 2013, while the qualitative findings have been transcribed, validated, and analysed using thematic analysis.

CT is considered a multidimensional concept that may be inadequately measured if the test for development is done once, hence the need for the pre- and post-test quantitative results obtained from the respondents. The qualitative results are used as the support and authentication of the critical skills existence in teaching and learning procedures presented by the qualitative interviewees (lecturers) to the quantitative interviewees (students).

There is a significant positive difference in the CT level of the 3rd year group pre- and post-intervention, yet no difference was identified for the 2nd year students; both groups were used as experimental groups. The CT skills improvement between the 1st year students (control group) and the 3rd year students (experimental group) is also significant.

From the qualitative study (interviews) the following themes have been developed:

i. New knowledge base and teaching skills
ii. Subject-based curriculum
iii. Assessment rules

In the next chapter, the themes formulated will be discussed together with the qualitative outcomes. Chapter Five also discusses concepts developed to guide the organisation.

CHAPTER FIVE: DISCUSSION

5.1 Introduction

The development of CT skills has always been an important outcome for students at tertiary institutions. CT supports in engaging the minds of students and enhancing the retention of knowledge, particularly for workplace preparation. Cognitive skills, in particular CT skills, incorporate important competencies for the 21st Century professions (Dewanto, Agustianto & Sari, 2018). This study explored the effect of gamification on the CT skills of ICT students. Chapter Five is presented as follows: i) quantitative results; ii) qualitative results; and iii) a combination of quantitative and qualitative results.

5.2 Discussion on quantitative results

From the findings in section 4.3.4.5, the interaction between the CT skills elements and the year of study for the participants were discussed and the results shown in Table 4.6. The following section discusses the CT skills elements in detail. Table 4.7 describes the link between the research questions and the findings from the quantitative study.

5.2.1 Critical thinking

The pre- and post-quantitative results of the study ($\mathbf{H_0: p_1 = p_2}$) showed no significant differences in the overall CT skills between all the groups (control and experimental). However, looking at the different individual CT elements (that make up the overall CT skills) there are some elements with significant differences between the groups (section 4.3.4.5, Table 4.6). These CT elements differ significantly from the 1st to the 3rd years and can be attributed to the gamification intervention. This finding is similar to Yerby et al. (2014:333), who found a correlation in the students' participation in voluntary activities and challenging assignments and between gamification and the percentage of students passing the course. However, other factors might also have contributed to the improved CT skills, namely:

i) The growth in maturity of the students (Mogale, 2012)
ii) The curriculum (section 4.5, Table 4.9, Finding 11), where Lopes (2014:572) highlights that gamification provides intrinsic motivation and stimulate creativity, thereby enabling students to cope with the subject curriculum
iii) Playing digital games in the relevant course or subject matter

Jayasinghe and Dharmaratne (2013:683) explain how game playing can be beneficial to all spheres of life to improve knowledge and content understanding. This is emphasised by Foxman (2014), who shows how gameplay and gamification have largely taken charge of many students' lives (social, education, health, religion, commercial, etc.).

Newman, Webb and Cochrane (2004) explored Garrison's (1992) five--stage model process of CT. Garrison's CT skills abilities are perceived to be similar to the problem solving process and include the following: i) problem identification skills (elementary clarification); ii) problem definition skills (in-depth clarification); iii) problem exploration skills (inference); iv) problem evaluation skills (judgement); and v) problem integration skills (strategy formation).

To understand the difference between the groups in terms of CT, a closer look at the findings as presented in Table 4.6 (section 4.3.4.5) is needed to determine which CT skills elements significantly improved among the groups. In the following section, the CT skills elements are discussed based on each question of the questionnaire given to the participants to complete.

5.2.2 CT skills elements

1Ho: α 1 = α 2 = α 3 = 0, and 2Ho: ß 1 = ß 2 = ß 3 = ß 4 = ß 5 and 3Ho: (αß) 11 = (αß) 12 = (αß) 13 = …. = (αß) 35 = 0

CT skills elements consist of problem identification (PI), in-depth clarification (IDC), and inference, judgement and strategy formation (SF). In the following sub-sections, the individual elements are discussed.

5.2.2.1 Problem identification (PI)

Landis et al. (2007:136) identify PI as the first step and basic stage in problem solving, which is 'process similar' to the abilities used in CT. Only the 3rd years showed a significant improvement from the pre- to the post-test when asked to identify situations that are not required for problem identification, thereby indicating their improved ability to identify problems after the gamification intervention. The results show that gamification at 3rd year level did improve the PI of the students. This improvement could be attributed to a combination of factors, but for this study, the only intervention was the gamification whilst all other factors were assumed constant. The 1st year and 2nd year groups could not answer the question correctly (Appendix A, section B, question 1).

5.2.2.2 In-depth clarification (IDC)

IDC is a form of logical thinking compounded in the CT skills. It encases accuracy, relevance, and significant thinking, which reduces surface and simple thinking. In-depth clarification is represented in the higher order of thinking (Paul, Elder & Bartell, 1997). According to the authors, clarification is a fundamental aim in teaching CT skills, as it is a concept that motivates the exemplary practices in teaching problem solving and CT skills to tertiary students. No significant difference in IDC was realised between the experimental groups when comparing the pre- and post-results of the study. The question that did have a significant change on the statistics (Appendix A, section C, question 4), prompted logical ways of thinking, as well as systematic and relevant rational thinking skills from the participants. Gamification had no influence in improving IDC in this group.

Deechai, Sovajassatakul and Petsangsri (2019:134) emphasise the importance of clarification as the key to concrete and fundamental perfection of thought. These philosophers show how clarification can be divided into two different levels, namely: i) elementary (focusing on a question and analysing arguments); and ii) advanced (defining the terms of judgement by form, strategy, and content, and identifying assumptions) (Deechai, Sovajassatakul & Petsangsri, 2019). IDC on its own shows both surface and high order thinking, which may be the reason why there was improvement in IDC for the 1st years only (Table 4.6, IDC2). The fact that the 1st year students are new in the tertiary education environment and had to alter their student life (maturity within the university) and/or the learning pattern (which might be the norm for the 2nd and 3rd year students) may have contributed to this improvement. The curriculum will improve from lower to higher level thinking with every advancing year of study (Priestley, 2017).

5.2.2.3 Inference

An inference is a conclusion on something based on the reality or evidence at hand (Paul & Elder, 2002; Mogale, 2012; Mezei, 2015). Inference is learned through experience (Reed, 2005). The experience may be based on using observations and background knowledge or even what is really known to inform a decision. Zulmaulida, Wahyudin and Dahlan (2018:3) differentiate clearly between inference and assumption, and describe assumptions as feeling-based and lack of thinking. No significant difference was found on this element between the experimental groups. However, a significant difference was observed on the inference element for the 1st years (Appendix A, section D, questions 8 & 10). These questions are interconnected and prompt students to deduce a complete argument and situations that might lead to an argument from a given list of different statements. This

improvement from the pre- to post-results within the control group cannot be attributed to the intervention, but might have been prompted by their recent experience based on their level of study curriculum.

According to Reed (2005:2), rational inferences are made on the reasoning and attitudes held based on what people believe. Doolittle et al. (2006:110) believe that inference is designed to offer students an opportunity to reconsider initial facts given by the source and making informed decisions based on their developing understanding of the context given. This description of inference may be encouraged by the curriculum (source), which results in how student conclude in making decisions. This is also supported by Paul and Elder (2008b:32) who said that people conclude by linking things with other concepts, in a process validating a certain set of inferences. Since inferences are learned through experience, Paul and Elder (2008b) gave a clear and precise way on how inferences are made “Because this is so, that also is so (or probably so)”. These authors further explain that inferences are created in one’s mind; they are “meaning-making constructs”. It is therefore important that one be careful to infer since the mind can create meanings well or poorly and may create more than what is implied (Paul & Elder, 2008b:30). Hyytinen et al. (2015:2) believe that an exaggerated picture of students’ competence, which may lead to an invalid inference for educators, is made when students give answers that they cannot generate on their own. This conclusion is based on the multiple-choice questionnaires that are given to students to choose or recognise a correct answer from a list of possible answers that they may never be able to generate on their own. Looking at these type of questions in (Appendix A, section D), the improvement may be attributed to guess work or even memorising the answer after the pre-test questionnaire session. This could also be a contributing factor that weakens the CT competence of the other groups.

5.2.2.4 Judgement

Judgement is mostly defined by an opinion or decision that is informed by a thorough thought process to make a decision (Zabit, 2010; Mogale, 2012; Pieterse, 2012; Pitt et al., 2015; Bowen, 2017). Judgement is associated with the highest stages of CT skills (Dwyer, Hogan & Stewart, 2014, 2015). A significant increase in judgement was observed for all participants between the groups on this element. In fact, this is the only CT element that showed the highest increase among all participants in the study (Table 4.6). The two questions (Appendix A, section E, questions 15 &16) that had a significant difference on the pre-test and post-test results, were based on analysing a given scenario, which was done to enforce deep thinking and analytical thinking skills.

Since this improvement was achieved by all groups (control and experimental), it can be concluded that the augmentation has been influenced by two factors encouraged by this study namely; i) the intervention (gamification) used, and ii) the subject based curriculum (Table 4.10, Findings 8 & 9). According to Rahim, Tie and Begum (2014:196), the use of the learning technology (gamification) has to be a process which integrates and supports greater critical and analytical thinking and problem solving skills because this is considered a sound learning opportunity for students than merely memorising and recite tasks. Dwyer, Hogan and Stewart (2014, 2015) categorise decision making and problem solving with knowledge utilisation which are viewed as important constituents of CT skills needed on daily basis for individual social and interpersonal contexts and development. The fact that the 1st years (control group) also had a significant difference between the pre-and post-results on one of the questions (Table 4.6), supports the reason for the development of CT skills in the subject-based curriculum.

5.2.2.5 Strategy formation (SF)

Judgement and SF go hand in glove, not only because of their high ranking in the CT skills stages, but also because of how SF is normally used or exposes itself as an ability (Giannakopoulos, 2012; Dominguez et al., 2015; Rodzalan & Saat, 2015). This is a distinct CT element, obligatory in executive and authoritative situations. SF is the creation or designing of strategies by exploration of most appropriate and relevant course of action to achieve a defined goal (Mangena & Chabeli, 2005; Pieterse, 2012; Dwyer, Hogan & Stewart, 2014). A significant augmentation in this skill was only realised within the 2nd year group. The question (Appendix A, section F, question 18) which had a significant difference from the pre-to post test results which tests students' ability in thinking where collation, analysis and accurateness in terms of relevance, and reliable decision-making was essential. This significant difference can be attributed to the gamification intervention. From the definition of SF and its associations (above), it is clear that SF is also a blended skill, not only does it include judgement but has a strong integral of inference, accuracy and relevance. Paul and Elder (2008a:8) maintain that, "a statement can be clear, accurate, and precise, but not relevant to the question at issue". Hu (2015) emphasises that high order (rank) CT skills need both intellectual skills (clarity, accuracy, precision, relevance, depth, breadth, fairness, logic, and significance) intellectual traits (confidence in reason, intellectual empathy and fair-mindedness) to be achieved. These reasons may be credited to the insignificance difference of SF for the 3rd year (experimental) group, and implies that the students may not have

achieved enough skills that are attached to SF (intellectual skills and traits) to attribute it as significant to the group.

5.3 Discussion on the qualitative results (themes discussion)

From the findings, three themes were developed: i) new knowledge base and teaching skill; ii) assessment rules; and iii) subject-based curriculum (Table 4.11). In the following sections, the research questions and themes are discussed. In Table 4.10, the link between the research questions and themes are shown.

Knowledge is virtue, it is therefore important that knowledge base learning encapsulates the knowledge that one already has (experience) and the knowledge that has to be acquired. According to Roessingh (2014), educators are required to understand the three knowledge base domains underlining the proficiency development in learning, namely content, pedagogical, and pragmatic knowledge. The lecturers who participated in this study understand the vitality of knowledge base theory and all agree that their students have some level of CT skills (IQ 1.1.2. & 1.1.3). This is also corroborated by the work of Salisbury and Karasmanis (2011), who state that students learn new skills while refining their existing skills, thereby advancing to more conscious knowledge of what they already know.

Teaching skills may also be a challenge in the learning programme, especially if it is for new content. It is known that if students are taught well, learning can be transformed (classrooms), resulting in enhanced educational outcomes. Although this is argued by some of the scholars, they believe that the absence of prior knowledge comprehension over emphasis on teaching skills may be a consequence of wasted opportunity in students' new skills engagements (Salisbury & Karasmanis, 2011). The realisation and cultivation of whatever CT skill (element) the students possess is therefore imperative in the teaching and learning process. So the knowledge base can be recognised in findings 1, 2, 3 and 12, while findings 13, 14, 15 and 17 emphasis new skills and teaching methods.

Gamification may be challenging if one does not understand the principles governing the games. Most of the educators find it hard to implement and use the games in the teaching and learning process simply because it requires a different knowledge base and teaching skills (Guerriero, 2014).

5.3.1 Theme 1: New knowledge base and teaching skill

Knowledge is virtue, it is therefore important that knowledge base learning encapsulates the knowledge that one already has (experience) and the knowledge

that has to be acquired. According to Roessingh (2014), educators are required to understand the three knowledge base domains underlining the proficiency development in learning, namely content, pedagogical, and pragmatic knowledge. Hegarty (2000:3) declares " The teacher is not only the recipient of these diverse knowledge inputs but must draw on his/her own pedagogical knowledge base to incorporate them into an appropriate learning programme". This implies that teaching is not the same as merely learning a subject content, it requires an immersed knowledge base and continual research intelligence on that appropriate learning programme to be able to transfer effective and efficient knowledge (Hegarty, 2000:13).

The lecturers who participated in this study understand the vitality of knowledge base theory and all agree that their students have some level of CT skills (IQ 1.1.2. & 1.1.3). This is also corroborated by the work of Salisbury and Karasmanis (2011), who state that students learn new skills while refining their existing skills, thereby advancing to more conscious knowledge of what they already know. Teaching skills may also be a challenge in the learning programme, especially if it is for new content. It is known that if students are taught well, learning can be transformed (classrooms), resulting in enhanced educational outcomes. Although this is argued by some of the scholars, they believe that the absence of prior knowledge comprehension over emphasis on teaching skills may be a consequence of wasted opportunity in students' new skills engagements (Salisbury & Karasmanis, 2011). The realisation and cultivation of whatever CT skill (element) the students possess is therefore imperative in the teaching and learning process. So the knowledge base can be recognised in findings 1, 2, 3 and 12, while findings 13, 14, 15 and 17 emphasis new skills and teaching methods. Gamification may be challenging if one does not understand the principles governing the games. Most of the educators find it hard to implement and use the games in the teaching and learning process simply because it requires a different knowledge base and teaching skills (Guerriero, 2014)

5.3.2 Theme 2: Assessment rules

Assessment rules or regulators are defined as practices regulated, which establish a clear guideline that ensures alignment of assessment strategies to support the achievement of intended learning outcomes effectively (Morgan, 2017; Mugimu & Mugisha, 2017). Determining the progress of newly acquired knowledge and the link to existing knowledge may be the most significant stage in the process of teaching and learning. Evaluation of knowledge base learning may differ from other assessments, since it allows the students to show what they have learned through application, which may include presentations and projects (Hornby, 2012; Mugimu &

Mugisha, 2017). Bilbao and colleagues (2018:29), identify the following attitudes as CT aligned assessment outcomes i) confidence in dealing with complexity, ii) Persistence in working with difficult problems, iii) Tolerance for ambiguity, iv) The ability to deal with open-ended problems, v) The ability to communicate and work with others to achieve a common goal or solution. Three of the interviewees expressed concerns around the formulation of assessment rules. According to Mugimu and Mugisha (2017:29), assessment regulators should evaluate the i) attitudes, ii) skills and iii) knowledge developed in learning. Assessment rules need to have the capability to evaluate the precise skills and competences acquired during the process of teaching and learning. This then is the reason why many lecturers would appreciate an opportunity to be part of evaluating or assessing the competences of their students' acquired knowledge. Based on the Table 4.9 (Findings 5, 6 & 11), it becomes clear that it is impossible to evaluate what is not taught, and similarly, it is impossible to ascertain the knowledge base presence if progress is not assessed. Compiling knowledge base assessments requires the disciplinary experts, which are the teachers educated in the relevant disciplines (Priestley, 2017).Most of the learning institutions have focused their vigour on the improved academic standards in such a way that they miss some important skills that should be acquired through learning. These skills may include the development of life and social skills given that education is there to develop the student holistically (Hornby, 2012).

Rules are important for any assessment as they guide students on how the university calculates their progress and results. Since gamification (intervention) in this study is used for assessment purposes (Serrano-Laguna et al., 2012:205) (section 3.5.1.1), it is important to show how the competence of gamification in the study is assessed by using those rules (section 3.5.1.2, Table 3.2). Students and lecturers need to know the precise rules of engagement. Assessment regulators do not directly encourage such an approach, as there is a tendency to play safe and not take risks. This however, may be a stumbling block to the holistic development of students' CT skills (Serrano-Laguna et al., 2012).

5.3.3 Theme 3: Subject-based curriculum

A curriculum is a clear definition of the programme vision that provides holistic and multi-layered knowledge and skills needed during the learning and teaching setting that identifies outcomes and understanding of that programme. Priestley (2017:2) views subject-based curriculum as an approach which identifies the holistic learning outcomes associated with agreed aims and objectives made by specific disciplinary expertise that are typically achieved by the end of a subject phase. This then needs

to be explicit about the degree to the subject matter on the following: i) when it is appropriate; ii) how to integrate IT knowledge to the subject matter; and iii) how it will be integrated into the faculty it belongs to (Priestley, 2017:1). Other scholars urge that subject-based curricula should be designed around the important ideas and skills that need to be acquired. It is encouraged that the subject-based curriculum be constantly reviewed to corroborate the intended quality, execution and the standards of delivery (resources) are accomplished (Kim, Kim, Yoon & Woo, 2019).

I4 commented on a very important teaching technique, which coerces students to apply and analyse subject contextual theoretical principles to complex situations for a possible solution through discussions, namely the case study teaching method. He also explained that this technique has been used on most of the subjects offered in IT. Some scholars agree that the utilisation of such teaching methods allows the scrutiny of students' problem-solving and CT skills; it also enhances professional skills development (Savery, 2006; Nkhoma et al., 2016).

While it is understood that university students have existing strengths and skills gaps, there is a need to intentionally prepare and design specific tools responding to building their individual thinking capacity (Salisbury & Karasmanis, 2011). Again, the realisation that the knowledge base, assessment regulators and the subject–based curriculum work hand-in-hand is an important factor. The subject-based curriculum specifies and emphasises the exact required and attained content knowledge for the subject and the assessment rules (the type, structure, and frequency) to be observed.

5.4 Conclusion

It is concluded that gamification through a thoroughly crafted subject-based curriculum guided by an adequate knowledge base and teaching conducted on precise assessment rules can improve and assist in the development of CT skills for tertiary students. The aim of the research was to explore the effect of gamification on the critical thinking skills of ICT students. This implies that the main exploration was based on the efficiency of gamification (intervention) to determine if it enhances the CT skills of the participating students (quantitative research), which were represented by the use of triangulation through conducting interviews with lecturers facilitating the individual modules in ICT (qualitative). This use of various methods to research the topic was done to authenticate and increase the rationality of the results by cross-checking and converging the quantitative results with the qualitative findings (Barlow-Jones, 2008; Gudmundsdottir, 2011).

It can be seen in Table 4.12 that the participating students' curriculum emphasises the development of CT. This gives the confidence that their thinking stages increase with the increased acquisition of critical elements through their years of study. However, according to Pucer, Trobec and Žvanut (2014:966), students must demonstrate one of the CT skills elements to fulfil CT competence.

5.5 Summary

This chapter discussed the themes that were developed during the qualitative data analysis as well as the results from the data analysed from the quantitative research. The researcher's interpretation of the merged results and reflections of the study were discussed. The quantitative study of this research, which was directly intended for the student participants in the study, discussed the gamification intervention and the degree of change in the CT skills among the participants. Different CT elements were discussed, tying the CT element findings and the participants' level of study as well as the research questions (Table 4.7). The qualitative study focused on interviews from the lecturer participants who were involved in teaching the participating students. The different themes discussed in this chapter were used collaborate and corroborate the qualitative and quantitative findings and the research questions of the study (Table 4.11).

Chapter Six provides the conclusion to the study and the recommendations on the research.

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

The aim of the research was to explore the effect of gamification on the critical thinking skills of ICT students. This chapter commences with the conclusions (section 6.2), followed by answering the research questions (section 6.3). Section 6.4 outlines the contribution to the study, followed by the constraints and limitations. Section 6.5 outlines the recommendations and proposes future research.

6.2 Overview of the research

Problem solving skills and CT skills are important not during teaching and learning only, but also in the workplace. The fact that these skills (CT and problem solving) are essential for the industry makes it clear that there is a need for the continuous development from basic to further learning education levels. CT skills are multifarious skills of thinking, which include problem identification, problem solving, accuracy, clarification, inference, judgement, conclusion, decision, and strategy formation. All these components of thinking are important on a daily basis. One of the main concepts in this study, *gamification*, is well defined in international literature. However, very little literature was found within the South African context relating to what the exact meaning of gamification is. Game design and game-based learning (GBL) or digital game-based learning (DGBL) are however well defined. This caused a misperception among some of the lecturers involved in the study, as they could not differentiate between these three concepts. Gamification in ICT education can be used to enhance engagement and retention of knowledge. The mere fact that games are used to engage, motivate and ignite curiosity in people's minds, indicates that gamification can be used as means to liberate the curiosity, motivation, engagement, and concentration of students.

CT skills can be taught and assessed. The only way to determine that CT skills have been taught thoroughly is through assessing these skills. The assessment of CT skills should therefore be a continuous exercise in the teaching and learning setting. Different CT models can be used to develop CT in a classroom setting. Since CT skills are compounded, models for the development can be focused on any of their constituent elements (problem solving, logical thinking).

Gamification differs from the DGBL or the GBL as it does not have to be in an academic environment (since no learning or building of games is required), and is therefore well applicable in the sales and customer-based environment.

Game elements are features in a game that enable the engagement of gamers in a game. These elements are used in most applications without notice to the players as they are embedded in the game. Rewards and points are used in a classroom setting to promote engagement of the students' participation in a task given during and after a pedagogical activity. GBL, DGBL, and gamification all have the constituency of games, which are a source of motivation, engagement and curiosity. This is a reason for the GBL and DGBL to be considered relaxed learning approaches.

Gamification is popular in the retail industry. The retailers use gamification in terms of loyalty points and budges (points, stamps) for customers to engage. The more you engage, the more rewards (points) you receive from the shop. Gamification has different models used in different environments to promote engagement and motivation to the users.

Concerns regarding the lack of CT and problem solving skills among students in the education system can be eradicated. However, this elimination cannot be instant, as it will take time, effort and skills. Gamification is one of the emerged new ways of teaching and learning in terms of ICT education and has been proven to be a source of motivation among the students.

Gamification promotes student-centred learning, as it is a hands-on approach of teaching and learning. Gamification can be used to aid teaching and learning as it allows students to acquire and retain knowledge while being entertained and motivated. CT supports in engaging the minds of students and enhances the retention of knowledge, particularly for workplace preparation. Although gamification is defined as the use of game elements in a non-game environment, it does not mean game designing or game building. More gamified learning approaches can still be discovered that may be used in teaching and learning environments. The mere fact is that CT skills support and engage students in the learning process while enforcing the acquiring and retention of knowledge.

6.3 Research questions answered

6.3.1 Research Question 1

RQ1: What are the challenges for ICT educators in teaching students to think critically?

SRQ 1.1: What thinking skills are to be considered for ICT teaching and learning to enhance critical thinking among students?

To answer this question, it is important to obtain the perceptions of the responsible lecturers on CT and the necessity of teaching CT skills to their students. The respondents agreed that CT skills are a necessity for all students, although different views on skills relevance were identified as conceptualisation, problem solving skills, logical thinking skills, independent thinking, and judgement. This reinforces the acknowledgement that CT skills are a composite skill, hence the definition of CT skills as the combination of elements (problem identification, In-depth clarification, inference, judgement, and strategy formation). Problem solving, logical thinking, independent thinking and judgement are all constituencies of CT.

SRQ 1.2: How can critical thinking be taught to ICT tertiary students?

Different modules were used with different levels and students. The objective of this question was to determine if a CT context has been included in each module as the lecturers stated. A subject-based curriculum (theme developed) was examined to identify CT and its components. It seems that all the modules taught have a section (if not all) that encourages teaching CT skills or CT elements. The conclusion of SRQ 1.2 is that although students possess a certain level of CT skills when entering university, students are also taught CT skills through case studies, scenario-based, and real-life experience-based activities during their teaching and learning tenure.

SRQ 1.3: How can critical thinking be assessed at tertiary institutions?

This question was solely responded to using the qualitative study results (interviews with lecturers), as the quantitative study participants were the students of which these CT skills were assessed. The question was intended to examine the assessment of CT skills. Based on the previous question (SRQ 1.2) and its findings, students were taught to think critically although different methods were used by different lecturers. It is then relevant to ask whether the CT taught to students is skilfully evaluated, how it is done, and who is responsible for the compilation of assessments and the module outline. Lecturers use application and deep thinking questions to assess CT skills, which allow students to apply their minds in responding to the questions. The results indicate that other resources (such as the Internet) and more innovative ways other than the use of the prescribed textbook are used as an assessment tool for CT. The evidence show (section 4.4.1.3) that students' CT skills are skilfully assessed, although not all lecturers presenting the modules in IT are given the chance to participate in the compilation of their module outline and assessments to ensure that CT is efficiently assessed. The conclusion drawn from these responses is that CT skills and its elements are taught and

assessed to the ICT students through different modules incorporated into their Diploma.

6.3.2 Research Question 2

RQ 2: How can gamification contribute towards thinking skills?

SRQ 2.1: How can gamification engage the student in critical thinking?

In the quantitative part of the study, SRQ 2.1 focused on the gamification intervention that was done with the participants (students). Most students are gamers, while most lecturers are neither familiar with nor interested in games. The fact that both parties (students and lecturers) agreed to the importance of games and their benefits is an inspiring factor of the study. To respond to SRQ 2.1, it is imperative to look into section 4.3.5 and section 4.4.1.4 to determine the perceptions and attitudes of the participants on games and gaming. This question presented different perceptions between the students and lecturers on the importance and relevance of gamification in their subject content. The researcher concludes that gamification can engage CT skills in students only when it is incorporated into their subject content.

SRQ 2.2: How can students use gamification as a tool to improve their critical thinking skills?

Table 4.12 shows how the subject-based curriculum theme was developed relating to the research questions of both the quantitative and qualitative part of the study. This question sought to determine the participants' thoughts on the integration of gamified activities to the normal subject content (section 4.3.5 & section 4.4.1.4) and (Appendix A, question 30 & Appendix B, IQ 2.2.1 & 2). The gamification intervention for the students was used as an additional assessment to the normal assessment criteria given to students. Again, both quantitative and qualitative participants supported the idea of incorporating gamified activities into the curriculum, as there was an increase of 11% from students' pre- to post-responses on the student questionnaires. The conclusion is that CT skills can be improved by incorporating game elements such as instant feedback, clear rules/goals, and randomness (to mention a few) into the subject curriculum.

6.4 Contribution to the study

The following are the contributions of this research to literature:-

- Highlighting the importance of utilising CT skills fundamentals (such as logical thinking, problem solving, and judgement, which promote creative thinking) in teaching and learning techniques.
- Providing an understanding of pedagogical implications in gamification lessons provided by the participants. Data was presented in both qualitative and quantitative manner to show the connection between the students CT skills and the efficiency of a gamified intervention to engagement the students, also supported by the relevant lecturers perspectives on the study.
- Exploring whether gamification could be a strategy to improve the CT skills of ICT students
- Investigating the novelty idea on the use of gamified presentation as way students learn. The flexibility of using game elements to support different learning styles.

CT has always been an important asset across all professions, although most of the literature consulted in this study was done in the medical field, mainly in nursing. The results and findings of this study coincide with the literature in Chapter Two, in that CT skills can be improved by using gamification and game elements to motivate and engage students in deep learning.

Gamification is an exhilarating theme on its own, which is employed by most institutes to increase engagement and enthusiasm in their participants. As CT skills were a major concept in the study that was measured and observed, much focus was directed to how it could be developed by means of teaching and evaluation. Gamification is a vast concept that is yet to be discovered in our country. Gamification is mainly employed for motivation and engagement and has different strategies that can be applied in different industries. However, much focus is directed to the teaching and learning setting. The findings advocated by the literature review in Chapter Two, show that gamification does motivate and increase engagement, interest and dedication to whatever subject it is applied to.

6.5 Limitations and constraints

This research, as with other pragmatic studies, is not without limitations. Most importantly, the study was done in a single UoT, chosen as a convenience sample by the researcher. The researcher chose to focus on a faculty in the university and concentrate on selected modules for the gamification intervention. Other faculties in the university enrol a larger number of students, which might have led to different outcomes than the selected faculty in the study; hence, the results and findings cannot be generalised. The availability of a constant group or groups was also

problematic as students' changed direction or simply left the course. Furthermore, with the high priority on teaching and study time, it was difficult to get time allocated for the testing and implementation of the intervention.

The study was limited to the lecturers teaching in, or who were involved with the ICT faculty only. The perspectives of other lecturers are however of utmost importance in the matter. The interviews were conducted only once, after the post-test results from the students were obtained. Pre- and post-interviews with the lecturers before and after the intervention may have contributed more to the research output.

6.6 Recommendations

6.6.1 Recommendations relating to the study

Notwithstanding the limitations of the study, the conclusions propose pragmatic strategies that may be applied in the development of CT skills and the CT elements. Existing strategies that can be used to create stimulating learning environments for both lecturers and students include the following:

- Subject-based content that can easily be incorporated into the curriculum
- Creating motivation to subject matters
- Changes the study pattern of students

The following recommendations were drawn based on the study:

i. Gamification can be used to improve CT.
ii. CT skills should be taught and evaluated across all the education levels, from basic to further education. This may encourage the development and improvement of CT skills.
iii. The confusion about DGBL, GBL, game design, and gamification need to be addressed and clarified in the South African context.
iv. Academic institutions should embrace the concept of gamification in their pedagogical activities as much as the DGBL and GBL were embraced.

Games can be used as learning tools. The use of GBL or DGBL, and game design in the classroom can be a powerful tool in teaching subject content. Gamification can be used in an academic and workplace setting to promote employee/employer relationships.

6.6.2 Recommendations for further research

The scope of the research can be extended by conducting a similar study in other faculties with a larger number of students at the university. The study should also include measuring the degree of CT applied in subjects taught based on each

component of CT with the application of each module gamified. Then the progress of the same level students (individuals) should be measured throughout the three years that the students are enrolled for the Diploma at the university.

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APPENDIX A: STUDENT QUESTIONNAIRE

Cape Peninsula University of Technology

INTRODUCTION

The purpose of this interview is to investigate the actuality of teaching and assessment for critical thinking skills within the Information and Communications Technology (ICT) department students, enrolled at a University of Technology (UoT) in Gauteng. It will also be used to explore the ICT students' enthusiasm in gaming as well as their fascination in playing while learning.

SECTION A - Personal Information

Please use an (X) to indicate your choice:

Gender

	Male
	Female

Age

	19 and younger
	20 – 29
	30 – 49
	50 – 59

When did you complete your Matric/Grade 12?

	1998 and earlier
	2004 and earlier
	2005 and later
	2010 and later

Subject enrolled for:

	Entrepreneur 1 module 1
	Information Systems 2 module 2
	Business Analysis 3 module 1

Please Indicate your MOST appropriate choice by using an (X) on the answer block provided below (MCQs):

SECTION B - Problem Identification

1. Which of these situations do NOT require problem solving?
   a. After you get your new home computer, you find there is no mouse in the box.
   b. When you get your pictures back from being developed, you realise they are someone else's.
   c. Everyone on your team wants to celebrate at the Burger Palace, but you just ate there last night.
   d. You have been assigned to finish a report for tomorrow morning, but it is your son's birthday, and you promised you would take him to the ball game tonight.

Answer:

A	B	C	D

2. Which of these problems is most severe?
   a. Your lecturer is sick and misses class the morning you are supposed to take a big exam.
   b. You lose track of your schedule and forget to study for a big exam.
   c. You cannot find one of the books you need to study for a big exam.
   d. The big exam is harder than you thought it would be and includes a section you did not study.

Answer:

A	B	C	D

SECTION C - In-depth Clarification

3. You conducted a successful job search, and now have three offers from which to choose. What can you do to most thoroughly investigate your potential employers? (Choose all that apply.)
   a. Check out their websites
   b. Watch the news to see if the companies are mentioned
   c. Research their financial situations
   d. Speak with people who work for them already

Answer:

A	B	C	D

4. You are trying to decide what kind of a car to buy. You make a chart to compare a two-seater sports car, a two-door sedan, and a minivan in three categories. Which one would NOT be a suitable category?
   a. Price
   b. Fuel mileage
   c. Tire pressure
   d. Storage capacity

Answer:

A	B	C	D

5. You read a story in the newspaper about salary negotiations with public transportation workers. The workers are threatening to go on strike tomorrow if their demands for higher wages and better benefits are not met. What can you conclude from this news story?

a. Health insurance premiums are very expensive.

b. The cost of fuel will make ticket prices increase in the next few weeks.

c. People who travel by bus should look for possible alternative transportation.

d. Employers never like to meet salary demands.

Answer:

A	B	C	D

6. Which scenario best represents a situation that has been decided through <u>emotion</u> alone?

a. Sue hates the winter in Joburg, so even though she cannot afford it, she takes a vacation to Mpumalanga.

b. The school shuts down after a bomb threat.

c. Third-quarter earnings for Marie's company were much higher than predicted.

d. Alexis needs a new mixer, so she watches the newspaper ads and buys one when it goes on sale.

Answer:

A	B	C	D

SECTION D - Inference

7. Choose the best conclusion for an argument that begins with, “The other members of Penny's swim team…”

a. Won their events, so Penny will win her event, too.

b. Have been swimming for at least six years, so Penny has been swimming for six years, too.

c. Prefer to swim in outdoor pools, so Penny prefers outdoor pools, too.

d. Wear swimsuits with the school logo on them, so Penny wears it, too.

Answer:

A	B	C	D

8. Which is NOT a sound argument?

a. Sabelo wanted to be a better figure skater, so he took extra lessons and practiced every day. His skating improved so much that he entered a competition.

b. Yesterday, a black cat ran in front of me, and later I lost my wallet. If I do not see that black cat today, I will not have any bad luck.

c. We had a storm with strong winds last night, and many trees were downed. There was a citywide power outage.

d. On a clear day, I can see the top of Carlton Centre from my house. If it is clear tomorrow, I'll be able to see the monument.

Answer:

A	B	C	D

9. Which is NOT a valid argument?

a. There are 6 cans of tomatoes in Carlo's pantry and 14 in his basement. There are no other cans of tomatoes in his house. Therefore, he has 20 cans of tomatoes in his house.

b. Everyone northbound on Daveyton yesterday was late to work. Faith was northbound on the

Interstate. Faith was late to work.

c. Rovhiwa comes from Nembilwi, Limpopo, Tembisa, Netshiendeulu, or Tswime. If he lives in Tembisa, then he is Sotho.

d. No one who eats in the cafeteria likes the pizza. My boss eats in the cafeteria. Therefore, my boss does not like the pizza.

Answer:

A	B	C	D

10. Which is NOT a likely cause of this situation? "I can't turn on the lamp in the family room!"

a. The lamp is not plugged into an electrical outlet.

b. We just bought a new couch in a colour that matches the lamp.

c. There is a power outage in the neighbourhood.

d. The light bulb in the lamp has burned out.

Answer:

A	B	C	D

11. What is wrong with the following argument?

"We should not change our grading system to numbers instead of letters. The next thing you know, they will take away our names and refer to us by numbers, too!"

a. The conclusion is too extreme.

b. There is nothing wrong with the argument.

c. Students should not have a say in the type of grading system used in their schools.

d. It does not explain why they want to get rid of letter grades.

Answer:

A	B	C	D

SECTION E - Judgement

12. What should you NOT rely on when making a judgment call?

a. Instinct

b. Common sense

c. Gossip

d. Past experience

Answer:

A	B	C	D

13. Which statement represents a judgment instead of a fact?

a. My presentation was excellent. I am sure my boss will promote me now.

b. My presentation was excellent. The clients all told me they liked it.

c. My presentation was excellent. It won an award from management.

d. My presentation was excellent. It was quoted as such on my peer evaluation.

Answer:

A	B	C	D

14. Which explanation is weakest?
    a. The steak was overcooked because I cooked it too long.
    b. Joseph did not drive his car today because it was in the shop for repairs.
    c. We do not belong to the country club anymore because we cannot afford it.
    d. Gugu overslept because she stayed up very late last night.

Answer:

A	B	C	D

Read the following paragraph and answer questions 15 and 16.

I always knew I wanted to be a marine biologist. When I was six, my parents took me to an aquarium, and I was hooked. But it was in college, when I got to work on an ocean research cruise that I decided to specialise in oceanography. The trip was sponsored by the Plankton Investigative Service, and our goal was to collect as many different types of the microscopic plants and animals as we could, in order to see what, if any, impact the increased number of people fishing there had on the marine ecosystem. Our group was divided into two teams, each responsible for gathering a different type of plankton. Working with the phytoplankton, especially the blue-green algae, was fascinating. We measured the chlorophyll in the water to determine where, and in what quantity, the phytoplankton was. This worked well because the water was so clear, free of sediment and contaminants.

15. What is phytoplankton?
    a. Another name for chlorophyll
    b. A microscopic plant
    c. A microscopic animal
    d. A type of fish

Answer:

A	B	C	D

16. The goal of the study group was to investigate whether more people fishing in the area had…
    a. A positive impact on the local economy.
    b. Depleted the supply of fish.
    c. Made more work for marine biologists.
    d. A negative impact on the health of the surrounding waters.

Answer:

A	B	C	D

SECTION F - Strategy Formation

17. Lindi's Business Analysis lecturer gives a quiz every Monday on the 50 p.s of reading he assigns on Fridays. His quizzes are becoming harder as the semester progresses, and Lindi has not been doing very well on them. What can she do to troubleshoot the problem and hopefully get better grades on the quizzes?
    a. Plan to get to class early on Monday to skim the p.s

b. Look for a new outfit to wear on Monday so she will be relaxed

c. Set aside time on Sunday to read and review the new material

d. Spend an hour on Saturday looking over what she missed on past quizzes

Answer:

A	B	C	D

18. When would it be better to do research in the library rather than on the Internet?

a. You are writing a report on recent South African economy analysis decisions.

b. You want to know the historical performance of a stock you are considering purchasing.

c. You need to compare credit card interest rates.

d. You want to find out more about the old abandoned and demolished building in your town.

Answer:

A	B	C	D

19. Which type of website most likely provides the most objective information about Nelson Mandela?

a. The home p. of a history professor who wrote a book on Mandela's presidency

b. An Allied group's site on famous assassinations, with the most p.s devoted to Mandela

c. The site of a historical preservation group that archives Mandela's correspondence

d. The official site of the presidential library in Cape Town, devoted to telling the life story of our first Black president

Answer:

A	B	C	D

20. You want to sell your three-year-old car and buy a new one. Which website would probably give you the best information on how to sell a used car?

a. Auto Trader: get the latest pricing and reviews for new and used cars; tips on detailing for a higher price

b. Better Business Bureau: provides free consumer and business education; consult us before you get started in your new business!

c. New Wheels: research every make and model of Detroit's latest offerings

d. Car Buying Tips: everything you need to know before you shop for your new car

Answer:

A	B	C	D

SECTION G – Game Play

Please use an (X) to indicate your choice:-

Are you interested in playing games?

	Yes
	No
	Maybe

If you say MAYBE please elaborate.

_____

_____

If you do, which game types fascinate you? Please name them?

_____

_____

How do you feel about incorporating game into subject matter in the lecture room?

	Strongly Agree	**Agree**	**Disagree**	**Strongly Disagree**
a) Make one playful				
b) Make one not to concentrate				
c) Make one loose the classroom conduct				
d) Refreshes one's mind				
e) Helps one to concentrate				

Would you be interested in using digital games incorporated in your subjects' content lectures?

	Yes
	No
	Maybe

If you say MAYBE, please elaborate.

_____

_____

APPENDIX B: INTERVIEW GUIDE

SEMI-STRUCTURED QUESTIONNAIRES

Interview schedule

Introductory remarks: The cultivation of critical thinking among tertiary students has always been an important outcome. Gamification has the potential to be used to engage learners in complex learning environments. On the other hand, critical thinking supports engaging the minds of students and enhances the retention of knowledge.

The aim: The study seeks to explore the effect of gamification on the critical thinking skills of ICT students.

We kindly request that you answer the questions below in good faith. Your answers will only be used for the purpose of this study and will be treated with the highest degree of confidentiality and privacy. Your participation in this interview is voluntary and allows anonymity as well as autonomy.

Section A: participant's details

Name: _____	Gender:_____
Surname: _____	Teaching Experience:_____
Age:_____	Level Teaching:_____
Position:_____	Date:_____
	Contact No.: _____

Section B: Questions

RQ1: What are the challenges for ICT educators in teaching students to think critically?
SRQ 1.1: What thinking skills are to be considered for ICT teaching and learning to enhance critical thinking among students?
IQ 1.1.1: Do you think critical thinking is important for your students? How do you feel about critical thinking? Comment:
IQ 1.1.2: Do you think your students are logical thinkers? Comment:
IQ 1.1.3: Do you think your students possess any critical thinking skills? Comment:
IQ 1.1.4: What thinking skills are to be considered for ICT teaching and learning to enhance critical thinking among students? Comment:
SRQ 1.2: How can critical thinking be taught to ICT tertiary students?
IQ 1.2.1: Do you think lecturers are supposed to teach students to think critically? Also, do you think students need to be taught to think critically? Comment:
IQ 1.2.2 Would you say that your subject content encourages you to teach critical thinking to your students? Comment:
SRQ 1.3: How can critical thinking be assessed at tertiary institutions?
IQ 1.3.1: How will you assess CT skills resourcefully? If yes, how do you make sure that it is assessed resourcefully? Comment:
IQ 1.3.2: Do lecturers have an input in subject content and syllabi that they present to their students? Comment:

IQ 1.3.3: Are you responsible for the subject content programme outline? If not, are you involved during the formation of the syllabi? Comment:
IQ 1.3.4: Are you responsible for assessing your students? If not, are you informed on how it is done? Comment:
RQ2: How can gamification contribute towards critical thinking skills?
SRQ 2.1: How can gamification engage the student in critical thinking?
IQ 2.1.1: How do you feel about gaming? Comment:
IQ 2.1.2: Do you think gaming is important for recent generation ICT students? Comment:
IQ 2.1.3: In your opinion, are there any cognitive benefits of gaming from gamers? Comment:
SRQ 2.2: How can students use gamification as a tool to improve their critical thinking skills?
IQ 2.2.1: Do you think gaming can be incorporated into your subject curriculum? Comment:
IQ 2.2.2: Are there any interesting approaches you can suggest to enable teaching critical thinking skills efficiently? Comment:

APPENDIX C: TRANSCRIBED INTERVIEWS

Interviewee 1

SEMI-STRUCTURED QUESTIONNAIRES

Interview schedule

Introductory remarks: The cultivation of critical thinking among tertiary students has always been an important outcome. Gamification has the potential to be used to engage learners in complex learning environments. On the other hand, critical thinking supports engaging the minds of students and enhances the retention of knowledge.

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Section A: participant's details

Name: Interviewer 1	**Gender:** Male
Surname: I1	**Teaching Experience:** +10 years
Age: 70 – 80	**Level:** Teaching 1st & 2nd years
Position: Lecturer: Programming Logic, Web Management	**Date:** 07/12/16 @03:46

Section B: Questions

RQ1: What are the challenges for ICT educators in teaching students to think critically?
SRQ 1.1: What thinking skills are to be considered for ICT teaching and learning to enhance critical thinking among students?
IQ 1.1.1: Do you think critical thinking is important for your students? How do you feel about critical thinking? Answer: "Absolutely vital." **Please elaborate on that…what do you mean?** Answer: "They need to be able to think in a critical fashion because very soon they will, are going to be out in the workplace and to assess situations that they are in, in a critical way." Answer: "Critical thinking to me is important because if we want some form of progress and even transformation we need to have some kind of change and change will probably only come if there has been critical thought behind."
IQ 1.1.2: Do you think your students are logical thinkers? Answer: "Some of them definitely are; one just has to bring it out…not only that, for them you need to show them that they are recognised, 'hey you are doing logical thinking now'"
IQ 1.1.3: Do you think your students possess any critical thinking skills? Answer: "A little bit."
IQ 1.1.4: What thinking skills are to be considered for ICT teaching and learning to enhance critical thinking among students? Answer: "One of the thinking skills that seem to need a lot of attention is ahh…conceptualising ideas and then logically trying to formulate a system out of those ideas, so logic to build up and then also conceptualising ideas into a composite concept you know, like ehh…a whole."
SRQ 1.2: How can critical thinking be taught to ICT tertiary students?
IQ 1.2.1: Do you think lecturers are supposed to teach students to think critically? Also, do you think students need to be taught to think critically? Answer: "Ohh Yes…I believe they should, I believe they should…the point is I don't know if we know how to go about it." **Which level do you think we should be then starting to teach critical thinking skills?** "At least in the second year of their National Diploma."
IQ 1.2.2: Would you say that your subject content encourages you to teach critical thinking to your students? Answer: "Ehm…not directly, it's sort of like a lecturer needs to almost interpret it indirectly from the content of the course."

SRQ 1.3: How can critical thinking be assessed at tertiary institutions?
IQ 1.3.1: How will you assess CT skills resourcefully? If yes, how do you make sure that it is assessed resourcefully? Answer: "Ehm…not directly, it's sort of like a lecturer needs to almost interpret it indirectly from the content of the course. Ok, I cannot speak for other where I haven't been involved obviously, but having been involved with programming and with Web there is enough in those subjects to get walking on to the logic path."
IQ 1.3.2: Do lecturers have an input in subject content and syllabi that they present to their students? Answer: "Very little, it's all dictated by the main campus. Yes, there are times where I am involved in the formation of the syllabi."
IQ 1.3.3: Are you responsible for the subject content programme outline? If not, are you involved during the formation of the syllabi? Answer: "No. they do programme outline, they give the whole student study guide. Yes, there are times where I am involved in the formation of the syllabi."
IQ 1.3.4: Are you responsible for assessing your students? If not, are you informed on how it is done? Answer: "Very little, it's all dictated by main campus."
RQ2: How can gamification contribute towards critical thinking skills?
SRQ 2.1: How can gamification engage the student in critical thinking?
IQ 2.1.1: How do you feel about gaming? Answer: "Ehh I am very open to it, I think it's great. It can be a great teacher, the problem that I personally have found and that is so to speak not for me, is the fact that when I go to the gaming situation on a computer, I get lost. It is not user friendly. I don't know why the heck they are trying to do what they try to do, ehh… but I do believe that there can be a hang of a lot of thinking in it." Ehh OK, ehh so if you do play games, which interests you? Answer: "Ehh…this guy that goes around and eats everything." OH PACMAN!! Answer: "Yes…"
IQ 2.1.2: Do you think gaming is important for recent generation ICT students? Answer: "Yes, no doubt." Why? Answer: "Ehh, because somehow they seem very attracted to it and almost without themselves knowing it; they are learning certain skills of moving in certain directions and even in certain thinking directions."
IQ 2.1.3: In your opinion, are there any cognitive benefits of gaming from gamers? Answer: "Ahh. Absolutely, especially when you use the word cognitive there is no doubt about it."

SRQ 2.2: How can students use gamification as a tool to improve their critical thinking skills?
IQ 2.2.1: Do you think gaming can be incorporated into your subject curriculum? Answer: “Yes, it would need some work but I think yes it can be incorporated, oh yes.”
IQ 2.2.2: Are there any interesting approaches you can suggest to enable teaching critical thinking skills efficiently? Answer: “Ok, in programming we often get examples of so called patches situations, eh these are the sales, these are the costs, so what are the margins? That kind of thing, which is very much, you know, it’s been going on for years. What we need there is also to put an example on turning it in a game where, ehh… oh, ahh, gosh, things like ehh… rolling the dice and then professing certain moves, and some moves might need to be more than four or less than two or whatever. We need to get a game aspect into it and not just always copy the business situation. We have had invoices and receipts since, you know.”

Interviewee 2

SEMI-STRUCTURED QUESTIONNAIRES

Interview schedule

Introductory remarks: The cultivation of critical thinking among tertiary students has always been an important outcome. Gamification has the potential to be used to engage learners in complex learning environments. On the other hand, critical thinking supports engaging the minds of students and enhances the retention of knowledge.

The aim: The study seeks to explore the effect of gamification on the critical thinking skills of ICT students.

We kindly request that you answer the questions below in good faith. Your answers will only be used for the purpose of this study and will be treated with the highest degree of confidentiality and privacy. Your participation in this interview is voluntary and allows anonymity as well as autonomy.

Section A: participant's details

Name: Interviewer 2	**Gender:** Female
Surname: I2	**Teaching Experience:** 15–20 years
Age: 40–50	**Level:** Teaching 1st & 2nd years
Position: Lecturer: Communication Skills and Entrepreneur Skills	**Date:** 09/02/17 @11:22

Section B: Questions

RQ1: What are the challenges for ICT educators in teaching students to think critically?
SRQ 1.1: What thinking skills are to be considered for ICT teaching and learning to enhance critical thinking among students?
IQ 1.1.1: Do you think critical thinking is important for your students? How do you feel about critical thinking? Answer: "Ehm… it depends on how you define critical thinking, how do you define critical thinking? What is your definition?" **It is more like the deep learning thing…you know when you try and determine more from just a simple knowledge…** Answer: "yah, I think it is important." Answer: "I think critical thinking needs to be taught; it is not something that comes naturally. Ahh…students need to be taught to think critically, like I said, in the past they need to be exposed to tasks that will allow them to think critically and if…I mean when you allow them to think critically, they don't just take anything at face value, it's like the news you know there is a lot of propaganda with the media, they won't just take anything without thinking about it."
IQ 1.1.2: Do you think your students are logical thinkers? Answer: "This can only show if you give them a chance to show it, but I cannot really say ehh…they are logical thinkers or not logical thinkers but when you give them a task, then from that task you are able to tell whether they were thinking."
IQ 1.1.3: Do you think your students possess any critical thinking skills? Answer: "Some students do, but some they don't. For some students if you give them maybe work or are working in class, you can actually see that they are thinking out of the box, they give you some answers you never thought about."
IQ 1.1.4: What thinking skills are to be considered for ICT teaching and learning to enhance critical thinking among students? Answer: "Really I don't think there should be any difference between the students that we teach, whether its ICT or tourism students because we are raising students in a 20th century where there is a lot of technology and you know like all the students are exposed to their use so I think it is just important to teach all the students critical thinking just like any other student. I think ICT students they also need to be exposed to exercises and assessments that allow them to think critically."
SRQ 1.2: How can critical thinking be taught to ICT tertiary students?

IQ 1.2.1: Do you think lecturers are supposed to teach students to think critically? Also, do you think students need to be taught to think critically?

Answer: "I think in the teaching thing there, you know it not like really planning to teach critical skills but maybe the work, the assessments that we maybe give to our students they should be channelled towards that route, the route which allows students to think on their own, so when you give exercises, that is when you know that you are giving them the platform to say, say whatever you think about this. You cannot actually plan to teach critical thinking."

Are we as lecturers doing that?

"I may not be very sure about other lecturers but with our department in Communication we try and do that as much as possible, getting from the work we give to our students. It calls for critical thinking."

IQ 1.2.2: Would you say that your subject content encourages you to teach critical thinking to your students?

Answer: "Yah…we are moving towards that, we are actually now have a section on ehh the steps that one needs to take towards critical thinking and even now the tasks that we now have…allow the student to think critically."

SRQ 1.3: How can critical thinking be assessed at tertiary institutions?

IQ 1.3.1: How will you assess CT skills resourcefully? If yes, how do you make sure that it is assessed resourcefully?

Answer: "Ahh, I think from what we have in our textbooks we can add when we discuss these things in class with the students and then you hear from them, it's not like the study guides that we use like the straight jacket you know. Students can come up with their new ideas that are not even there in the textbook."

IQ 1.3.2: Do lecturers have an input in subject content and syllabi that they present to their students?

Answer: "Ahh…just a little bit."

IQ 1.3.3: Are you responsible for the subject content programme outline? If not, are you involved during the formation of the syllabi?

Answer: "We only help them, a few, I would say in communication, so much of the work is centralised, but ahh…here and there they ask like individuals to suggest maybe exercises or questions for a semester test, so in a way, yes, though it is not in your name."

"No, no…"

IQ 1.3.4: Are you responsible for assessing your students? If not, are you informed on how it is done?

Answer: "No, a few…maybe a question or two."

RQ2: How can gamification contribute towards critical thinking skills?

SRQ 2.1: How can gamification engage the student in critical thinking?

IQ 2.1.1: How do you feel about gaming?

Answer: "You know when you talk about games they just state about non-educational games, yes, so sometimes now because you teach ICT, I am not very sure and ahh…not very familiar with the games that you can use in ICT that can benefit students, you know."

IQ 2.1.2: Do you think gaming is important for recent generation ICT students? Answer: “Hmm yah…I don’t think there is much difference when it comes to the courses that the students are taking because the students that we have now, they are all, you know, into new technology, they are digital natives, they are born during this period where you know…of technology.”
IQ 2.1.3: In your opinion, are there any cognitive benefits of gaming from gamers? Answer: “Yahh, I think yah, yah, yah…”
SRQ 2.2: How can students use gamification as a tool to improve their critical thinking skills?
IQ 2.2.1: Do you think gaming can be incorporated into your subject curriculum? Answer: “Yah,…time allowing, I think it will help students I mean they are forever on technology so giving them electronic games it will also…like they will enjoy the games.”
IQ 2.2.2: Are there any interesting approaches you can suggest to enable teaching critical thinking skills efficiently? Answer: “Yah, I think apart from the electronic games, I think we can move away from the teacher-centred approach of teaching and allow the students to take the centre stage in the teaching and learning process and then allow them to unleash whatever they have in them and not limit them and also that way I mean they will you know show that the teacher is not the only source of information; they can also bring new information.”

Interviewee 3

SEMI-STRUCTURED QUESTIONNAIRES

Interview schedule

Introductory remarks: The cultivation of critical thinking among tertiary students has always been an important outcome. Gamification has the potential to be used to engage learners in complex learning environments. On the other hand, critical thinking supports engaging the minds of students and enhances the retention of knowledge.

The aim: The study seeks to explore the effect of gamification on the critical thinking skills of ICT students.

We kindly request that you answer the questions below in good faith. Your answers will only be used for the purpose of this study and will be treated with the highest degree of confidentiality and privacy. Your participation in this interview is voluntary and allows anonymity as well as autonomy.

Section A: participant's details

Name: Interviewee 3	**Gender:** Male
Surname:I3	**Teaching Experience:** 2–4 years
Age: 30–40	**Level:** Teaching 1st, 2nd & 3rd years
Position: Lecturer: Information Systems and Business Analysis	**Date:** 23/02/17 @03:48

Section B: Questions

RQ1: What are the challenges for ICT educators in teaching students to think critically?
SRQ 1.1: What thinking skills are to be considered for ICT teaching and learning to enhance critical thinking among students?
IQ 1.1.1: Do you think critical thinking is important for your students? How do you feel about critical thinking? Answer: "Yes, it is very important. Why? Because the students are actually taught to go and solve real life problems so they need to have that CT to be able to solve those problems that are out of here."
IQ 1.1.2: Do you think your students are logical thinkers? Answer: "I think it differs from group to group, there are those types that have heretical skills or [are] very bright; there are those types that are average students. I will say it differs from group to group, maybe because on how I enhance the critical thinking. I think it's also being governed by other subjects are they actually being taught – how to think logically or just to pass so it's not a one man's job, it depends on [the] role of other educators." Logical vs. critical vs. analytical Answer: "Logical, I would say it's about being able to bring all the pieces together from different subjects or different scenarios and being able to [do] what? To also show… is being able to take one piece that and one piece there and combining them to be able to solve them." Like a puzzle Answer: "Yah...like a puzzle, so say one puzzle was missing from a certain group or certain educator, they did not impose a certain aspect, then the student needs to recap there and there." So, you are saying a full piece is analytical and can be disintegrated into logical thinking, so if they can think logically then they have analytical thinking and therefore can think critically. Answer: "Yes."
IQ 1.1.3: Do you think your students possess any critical thinking skills? Answer: "I can't say all of them but some do particularly because they are coming from vocation courses; also they don't expect them to think even before our programme but some they have done maybe depending on the kind of background they come from."
IQ 1.1.4: What thinking skills are to be considered for ICT teaching and learning to enhance critical thinking among students? Answer: "I think the ability to analyse the problem, being analytical is very important because if students are not analytical it becomes a problem, then they can't solve any problems, give them a problem you need to get a solution but is that form being able to analyse what is required of them? I think, I think like we are saying the case study approach itself it actually shows you, so in that way I will say we are also enhancing their analytical skills".
SRQ 1.2: How can critical thinking be taught to ICT tertiary students?

IQ 1.2.1: Do you think lecturers are supposed to teach students to think critically? Also, do you think students need to be taught to think critically? Answer: "The case study approach of IS, I will say that it is the one that teaches the students how to think because that is where they are shown the real life experience that they have to analyse; even BA itself, it requires them to think critically because they are presented with scenarios. Otherwise, the rest of the subjects, I may not be sure about those in programming…I have not taken programming but I know it teaches them to think critically, must be how to think critically, I think importantly they will." **Are we as lecturers doing that?** Answer: "Yes."
IQ 1.2.2: Would you say that your subject content encourages you to teach critical thinking to your students? Answer: "Yes (with all) yes those two were…"
SRQ 1.3: How can critical thinking be assessed at tertiary institutions?
IQ 1.3.1: How will you assess CT skills resourcefully? If yes, how do you make sure that it is assessed resourcefully? Answer: "Yes (with all) yes those two were… Ehh, it all goes back to when we were saying in case studies because if the students are going to solve real life case studies then it means in such way they are being resourceful, they are contributing, but the other thing that would be missing that one wish[es] could be done is maybe done at a later stage, not when you are teaching. You give them to go out for industry and come back and draw a system from onset. I think that way it makes it to be very resourceful because we know that what they have been getting throughout they can actually go out and put it into practice."
IQ 1.3.2: Do lecturers have an input in subject content and syllabi that they present to their students? Answer: "IS yes, there was an input but with the other subjects there isn't."
IQ 1.3.3: Are you responsible for the subject content programme outline? If not, are you involved during the formation of the syllabi? Answer: "With IS I was doing it. I was the one setting tests so in that level I can see it. It was only IS. Yes to some extent to the class tests and semester tests."
IQ 1.3.4: Are you responsible for assessing your students? If not, are you informed on how it is done? Answer: "With others, I get the study guide and get the test and write the test. With IS, I was doing it. I was the one setting tests so in that level I can see it. It was only IS".
RQ2: How can gamification contribute towards critical thinking skills?
SRQ 2.1: How can gamification engage the student in critical thinking?
IQ 2.1.1: How do you feel about gaming? Answer: "I am not very good in gaming, I am actually the bad looser".

IQ 2.1.2: Do you think gaming is important for recent generation ICT students? Answer: “Yes. Why am I saying so? Because when you are gaming you need to think ahead, you need to think fast and those are in fact, mainly thinking fast actually trains your brain just like me emotionally, I am a bad looser. But gaming itself, it increases your thinking capacity, just like when you are playing the simple FIFA, you actually need to know or see opponents make decisions fast about passing of ball.”
IQ 2.1.3: In your opinion, are there any cognitive benefits of gaming from gamers? Answer: “Yah, if you are using it to enhance your knowledge and it can be valid, how? Ok I made an example of FIFA that it can actually train your mind because also when your mind is relaxed when you do something educationally it also increases, sharpens your mind, and another thing, we can play Scrabble; it teaches you how to think and then how to even increase your capabilities.”
SRQ 2.2: How can students use gamification as a tool to improve their critical thinking skills?
IQ 2.2.1: Do you think gaming can be incorporated into your subject curriculum? Answer: “Hmm, it is going to be beneficial but for those bad losers like me yah for other students it might not work but for others it will be beneficial.”
IQ 2.2.2: Are there any interesting approaches you can suggest to enable teaching critical thinking skills efficiently? Answer: “I think the best way is let’s give them real life experiences. If [it] to be through the game, let it be based on real life experiences so in that way education is taken out of the classroom into the community; then that way [it] will increase critical thinking because in that way you are encountering the real problem.”

Interviewee 4

SEMI-STRUCTURED QUESTIONNAIRES

Interview schedule

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Section A: participant's details

Name: Interviewee 4	**Gender:** Male
Surname:I4	**Teaching Experience:** 2 – 4 years
Age: 30 – 40	**Level:** Teaching 1st & 2nd years
Position: Lecturer Information Systems	**Date:** 09/02/22 @09:34

Section B: Questions

RQ1: What are the challenges for ICT educators in teaching students to think critically?
SRQ 1.1: What thinking skills are to be considered for ICT teaching and learning to enhance critical thinking among students?
IQ 1.1.1: Do you think critical thinking is important for your students? How do you feel about critical thinking? Answer: "Yes I think it is, especially because they are doing IT; it is important that they think out of the box."
IQ 1.1.2: Do you think your students are logical thinkers? Answer: "Yes, they are logical thinkers." **Although you are also teaching them logical thinking?** Answer: "Yes, just to strengthen and make sure that they become more logical thinkers."
IQ 1.1.3: Do you think your students possess any critical thinking skills? Answer: "Yes, I think they do; it is up to us to show them ways of how they can become more critical thinkers because they possess something, they come with something when they come to universities."
IQ 1.1.4: What thinking skills are to be considered for ICT teaching and learning to enhance critical thinking among students? Answer: "Hmm thinking skills? Hmm what are you referring to?" **Any other thinking skills that you may think of even maybe logical thinking hmm because we are busy with critical thinking, maybe deep thinking. Which skills do you think are more important especially for IT students?** Answer: "I think critical is important and also logical is also important because they need to understand the logic behind whatever module that ehhm they are being taught. If its information systems, they have to develop the system, they have to understand the logic, how to come about, what are different phases…because sometimes you will find that for an instance you want to develop a system but there are different ehhm ways of you to develop a system. There's a first phase where it is about seven phases, the CMM phase, which has got four phases, but all of them, they are used for system development. So they are different but this requires the person to understand the logic behind the system that's being developed, and also to be a critical thinker so that you would analyse, you look at the problem and come up with possible solutions and decide which one is more viable for that problem." **So analytical, logical and critical thinking skills are supposed to be taught together?** Answer: "Yes it is important because at some stage before you develop the system, especially for IS, you need to study what are the problems there because we expect the student when he complete this module he is able to engage with someone. Remember the person who wants the system, that person is business driven but you as a student, you will be coming from an IT background so you must be able to analyse that system to show opportunities to that person funding the system because that

system is not coming from the IT background but is only business driven. So you need to show him the other opportunities that are coming and also the problem the person might see, only the specific problem for the current system, but you [are] analysing, interviewing people, ehhm… trying to understand what are other unforeseen problems that may occur. Maybe in two years' time you need to have that analysing skills."

SRQ 1.2: How can critical thinking be taught to ICT tertiary students?

IQ 1.2.1: Do you think lecturers are supposed to teach students to think critically? Also, do you think students need to be taught to think critically?

Answer: "Yes, it is important that we teach them how to think critically."

Although they do possess something they come with…?

Answer: "Yes we need to teach them although they have something that they have."

IQ 1.2.2: Would you say that your subject content encourages you to teach critical thinking to your students?

Answer: "Yes it does, the way it is structured it allows students some part of the content, which we cover for IS. It allows them to be logical thinkers, part of it allows them to be critical thinkers because they need to think critically before they make a decision on which solution they are going to use for the system."

SRQ 1.3: How can critical thinking be assessed at tertiary institutions?

IQ 1.3.1: How will you assess CT skills resourcefully? If yes, how do you make sure that it is assessed resourcefully?

Answer: "In terms of assessment of critical thinking, it is the way you set your questions; you must make sure that you allow the students to apply their minds unlike asking questions such as "define", where you expect the students to recap or memorise to tell you exactly what the textbook say[s], but then they need to apply whatever content they have learned to a specific situation in a specific case study – then they apply what they have learned."

Using case study scenarios?

Answer: "Yes."

IQ 1.3.2: Do lecturers have an input in subject content and syllabi that they present to their students?

Answer: "Everything is done there, we don't have."

So when you say there…where is there?

Answer: "Main Campus."

Ooh Ok but you are told on how it is done at the end of the day.

Answer: "Yes, they do ask for contributions from all the lecturers responsible for the subject before they make the decision."

IQ 1.3.3: Are you responsible for the subject content programme outline? If not, are you involved during the formation of the syllabi?

Answer: "Hmm, no, normally there's a subject head and they ask like what inputs do we have, they send us like hmmm syllabus and communicate via emails."

Answer: "They do ask, but the decision is taken that side."

So you do have an input although it might not be part of the syllabus?

Answer: "Yes."

IQ 1.3.4: Are you responsible for assessing your students? If not, are you informed on how it is done?

Answer: "Not right now, I am not."

Even tests and maybe exams?

Answer: "Yeah for the first time this year I am doing the exam this year….yah."

OK

RQ2: How can gamification contribute towards critical thinking skills?

SRQ 2.1: How can gamification engage the student in critical thinking?

IQ 2.1.1: How do you feel about gaming?

Answer: "Gaming in general is fine because it allows a number of people to reduce stress levels…you know because it takes you out of whatever environment that it takes you, somewhere else where you are free, you know, if you play a game you can lose you, can win. It changes your mindset, you know, so they do say gaming reduces the stress levels."

IQ 2.1.2: Do you think gaming is important for recent generation ICT students?

Answer: "To play games? Yes, it is important because when they play games they concentrate more because you've got a target that you want to achieve."

IQ 2.1.3: In your opinion, are there any cognitive benefits of gaming from gamers?

Answer: "Yes, I think there are, because once you reach a specific level you want to reach, the next time you play the game you want to reach a higher level, you want to beat your current score like Tetris…you reach a specific level the next time you want to bear a specific score that you want to accomplish."

What is educational about that?

Answer: "You know, gamification assists you in terms of… let's say a game like Chess, it assists you think critically, like I said before and it allows you to concentrate to look at the movement which if I make this move, if I make that move what will happen."

So it allows you not to make the same mistake twice?

Answer: "Yes, because you learn from your mistakes."

SRQ 2.2: How can students use gamification as a tool to improve their critical thinking skills?

IQ 2.2.1: Do you think gaming can be incorporated into your subject curriculum? Answer: “Yes, it can; however, it depends on the availability of resources. If it’s going to be your digitalised games, that will require more time for you as a lecturer unless if you have got a team that will assist you to develop a game and also, but if you are going to use like your paper-based games or your additional games, it’s going to be simple for you to assess your students with it. But I think the digitalised games will require more resources but if resources are there then…I think we should consider using them for assessing our students.”
IQ 2.2.2: Are there any interesting approaches you can suggest to enable teaching critical thinking skills efficiently? Answer: “Hmmm when I look at the way we assess our students, maybe it is also important to put, you know, where you put something like a game as part of the question already. When they look at that question paper, there being a game already drags the attention so I think maybe gamification is the way to include maybe as part of the assessment.”

Interviewee 5

SEMI-STRUCTURED QUESTIONNAIRES

Interview schedule

Introductory remarks: The cultivation of critical thinking among tertiary students has always been an important outcome. Gamification has the potential to be used to engage learners in complex learning environments. On the other hand, critical thinking supports engaging the minds of students and enhances the retention of knowledge.

The aim: The study seeks to explore the effect of gamification on the critical thinking skills of ICT students.

We kindly request that you answer the questions below in good faith. Your answers will only be used for the purpose of this study and will be treated with the highest degree of confidentiality and privacy. Your participation in this interview is voluntary and allows anonymity as well as autonomy.

Section A: participant's details

Name: Interviewee 5	**Gender:** Female
Surname: I5	**Teaching Experience:** +20 years
Age: 50–59	**Level:** Teaching Foundation & 1st years
Position: Lecturer: Communication and English Language Skills	**Date:** 09/02/17 @11:22

Section B: Questions

RQ1: What are the challenges for ICT educators in teaching students to think critically?
SRQ 1.1: What thinking skills are to be considered for ICT teaching and learning to enhance critical thinking among students?
IQ 1.1.1: Do you think critical thinking is important for your students? How do you feel about critical thinking? Answer: "Yes, I think it is important because students are supposed to think critically so that they can support their statements and be independent."
IQ 1.1.2: Do you think your students are logical thinkers? Answer: "Yes they are logical thinkers because they are actively involved in their education; they make progress as they confirm the correct responses and their learning proceed[s] from the simple to the complex in a systematic manner." **Would you say a logical thinker is a critical thinker?** Answer: "Logical thinking, I think is a critical thinking with the fact if you cannot think logically, you cannot be critical. I think they go hand-in-hand….yes."
IQ 1.1.3: Do you think your students possess any critical thinking skills? Answer: "Yes, by the virtue of the fact that they have chosen to do IT, to me they saw it was on demand and they wanted to prove their critical thinking skills; yes, they come with their own but it needs to be guided."
IQ 1.1.4: What thinking skills are to be considered for ICT teaching and learning to enhance critical thinking among students? Answer: "I think the subject knowledge, the love for the subject, moral uprightness, fairness and enthusiasm, understand student's problems and ability to explain clearly enhance critical thinking among the students." **Do we have different skills to teach for ICT students only or this can be for all students as well?** Answer: "As far as I see there is no difference between the other streams and the ICT by the virtue of the fact that the student is supposed to learn all these skills are necessary but they differ according to the line that the student has taken for instance if he is doing Auditing, ICT is different from Auditing but you are using the same, you must have knowledge of the subject, you must have that fairness and that moral uprightness."
SRQ 1.2: How can critical thinking be taught to ICT tertiary students?
IQ 1.2.1: Do you think lecturers are supposed to teach students to think critically? Also, do you think students need to be taught to think critically? Answer: "Yes, I think critical thinking must be taught to think critically in order to solve problems independently and be responsible for their own education."

IQ 1.2.2: Would you say that your subject content encourages you to teach critical thinking to your students?

Answer: "Yes my subject content encourages students to think critically; the reason why I say so is because for instance, I am teaching language if the student being asked a question and does not answer the way it is supposed to be answered that is…the critical thinking was not applied there so the student needs to think first before answering the question correctly, so I think the critical thinking is always supposed to be applied."

Do you have sections that are set for teaching critical thinking?

Answer: "Yes, yes."

SRQ 1.3: How can critical thinking be assessed at tertiary institutions?

IQ 1.3.1: How will you assess CT skills resourcefully? If yes, how do you make sure that it is assessed resourcefully?

Answer: "Kindly please repeat the question….ok…I think it can be resourcefully assessed if the students are exposed maybe to sources or resources like the internet and television, and so that they can get information, full information, and apply it and after that being assessed. But I think the students who are from the rural areas can suffer because internet and television is not available, but I think the resources like internet and TV make the students to be critical thinkers and can be assessed fully."

IQ 1.3.2: Do lecturers have an input in subject content and syllabi that they present to their students?

Answer: "Yes, lecturers are supposed to think critically, so that they can, so that their thinking can be based on facts and their ideas supported by evidence."

IQ 1.3.3: Are you responsible for the subject content programme outline? If not, are you involved during the formation of the syllabi?

Answer: "I am not allowed, I just get a syllabus as it is and therefore transfer it to the students of which… ehh I see that as not being correct because I am always with these students, every day, I see the students' needs. I think I should have an input."

Especially for the syllabi?

Answer: "Exactly!"

IQ 1.3.4: Are you responsible for assessing your students? If not, are you informed on how it is done?

Answer: "I assess what I did not compile as a syllabus however having taught the students I teach them to answer questions, as they are, so that they cannot be lost. Sometimes even me, as far as the syllabus is concerned, sometimes it makes me not to understand what the examiner wants the student to know but if I was part of compiling the syllabus I think I would know the needs of the students."

Are you informed about the syllabi?

Answer: "Yes the coordinators call me to the meetings or workshops where we discuss the syllabus which I am uninformed about what is expected of the students. Yes I am not part."

RQ2: How can gamification contribute towards critical thinking skills?

SRQ 2.1: How can gamification engage the student in critical thinking?

IQ 2.1.1: How do you feel about gaming?

Answer: "Gaming. I think gaming is to play computer game[s]. Students learn as they play therefore I support it because while the student is gaming also the information is gained unnoticed."

What information do they gain?

Answer: "I am going to make an example…maybe the lecturer stands in front and lifting up maybe hands in order for the students to count without a voice so while he is lifting up the hands and hamming [sic] the students understand what he means because he's using his hands as a form of gaming."

IQ 2.1.2: Do you think gaming is important for recent generation ICT students?

Answer: "I think so because not every student is easily understanding information like the others."

So they have different learning styles?

Answer: "Yes, yes, they have different learning styles as a result gaming, is very, very important."

IQ 2.1.3: In your opinion, are there any cognitive benefits of gaming from gamers?

Answer: "I think students are developed mentally and are actively involved in ICT because we deal with students that are different; they have different ways of doing things so the development mentally is acquired while gaming is being applied. Cognitive has to do with thinking skills yes, since they are unique I think there is something that maybe three out of ten will benefit from that."

SRQ 2.2: How can students use gamification as a tool to improve their critical thinking skills?

IQ 2.2.1: Do you think gaming can be incorporated into your subject curriculum?

Answer: "I think so because gaming is important to IT to get knowledge and understanding and explore information and to become exposed to ICT … I think so."

So you mean only digital games, computer games will be a benefit so what about the games like Scrabble (board games), any benefit?

Answer: "I think they are also related to ICT, the board games the students some of them can gain a lot from them."

IQ 2.2.2: Are there any interesting approaches you can suggest to enable teaching critical thinking skills efficiently?

Answer: "Yes I think students can read magazines and newspapers to expand and increase their knowledge so that they can think out of the box, watch TV and listen to media and comments from the media, basic concepts and new work can be introduced and the topic given to students should be sufficiently interesting to warrant a lively discussion."

Do you think our students are not already listening to media?

Answer: "Some of the students that we are having are coming from rural backgrounds; maybe that there is no phone, no TV, they would go to the neighbours to watch TV, so since every student is unique all the possible avenues must be explored so that the learners can be developed in totality."

APPENDIX D: PRESENTATION RUBRIC

Presentation Rules

All presentations should be a maximum of 15 minutes, 8-10 minutes for the presentation itself and 3-5 minutes for questions and comments. Presentation numbers will be assigned to all students, and we will therefore proceed with the presentation sequentially. All students must come prepared for the presentation, as we are not going to wait for anyone that is absent or late.

Points

Rewards will be as follows:

Presentation Skills – a well prepared presentation, an indication of knowing and understating one's business and being able to respond well to questions asked after the presentation. This weighs 80% of your overall mark.

Participation – contribution and involvement during another's presentation e.g. input on one's presentation, questions, and comments. This weighs 10%. Teamwork is important in BA.

Apparel – appearance during your presentation is important and will be awarded 10%, the more professional look you have, the more awards you get.

This will therefore take over the last section (Section 4B) on your study guide. We will consequently combine the mark for ERDs and DFDs in one section (Section 4A).

Attendance

Attendance is compulsory, whether one is presenting or not; 5% will be deducted for every missed presentation. Please note that this mark is recurring and accumulative, which means that for the 1st person's presentation that one misses, a 5% is deducted, and for the next 10%, then 15% and so on.

Late coming will not be tolerated if a class attendance register is marked before one arrives in class; therefore, that student will be considered absent for the presentation class.

Breaks will only be taken after the presentation is done (during questions/comments time).

Student Number_____ **Group Name**_____

	Poor				Excellent
PRESENTATION SKILLS	**1**	**2**	**3**	**4**	**5**
Were the main concepts presented in an orderly and clear manner? Did the presentation fill the time allotted? Were the overheads/handouts appropriate and helpful to the audience? Did the talk maintain the interest of the audience? Was there a theme or take-home message to the presentation? Was the presenter responsive to audience questions? Were all members of the group presented and knowledgeable about the presentation?					
KNOWLEDGE BASE	**1**	**2**	**3**	**4**	**5**
Was proper background information on the topic given? Was the material selected for presentation appropriate to the topic? Was enough essential information given to allow the audience to effectively evaluate the topic? Was irrelevant or filler information excluded? Did the presenter have a clear understanding of the material presented?					
CRITICAL THINKING	**1**	**2**	**3**	**4**	**5**
Were the main issues in this area clearly identified? Were both theoretical positions and empirical evidence presented? Were the strengths and weaknesses of these theories, and the methods used to gather this evidence adequately explained? Did the presenter make recommendations for further work in this area? Did the main conclusions of the presentation follow from the material presented? Were the competing explanations or theories considered and dealt with properly?					

APPENDIX E: CT QUIZ ANSWERS

Cape Peninsula
University of Technology

Critical Thinking Assessment Practice Quiz Answers

1. **a, c, d**
2. **c.**
3. **d.**
4. **c.**
5. **b.**
6. **c.**
7. **a.**
8. **d.**
9. **c.**
10. **b.**
11. **c.**
12. **c.**
13. **c.**
14. **a.**
15. **d.**
16. **c.**
17. **d.**
18. **b.**
19. **a.**
20. **d.**
21. **c.**
22. **b.**
23. **d.**
24. **a.**
25. **a.**
26. **b.**
27. **c.**
28. **a.**
29. **c.**
30. **b.**

APPENDIX F: CONSENT AND ETHICS CLEARANCE FORMS

REC 5

CAPE PENINSULA UNIVERSITY OF TECHNOLOGY

Ethical Considerations for Questionnaires and Interviews
Faculty of Business Research Ethics Committee

Tick One Box:

Staff Project

Contract Project

√**Postgraduate Project (Masters and Doctoral level)**

Undergraduate Project (ND & BTech level)

Title of Project: Gamification as a tool for developing critical thinking among ICT students at a tertiary institution in South Africa

Name of researcher(s): NF Mposula

Name of Supervisor(s) (if appropriate): Dr AC de la Harpe

		YES	NO	N/A
1	Will you describe the main experimental procedures to participants in advance, so that they are informed about what to expect?	**X**		
2.	Will you tell participants that their participation is voluntary?	**X**		
3.	Will you obtain written consent for participation?	**X**		
4.	If the research is observational, will you ask participants for their consent to being observed?	**X**		
5.	Will you tell participants that they may withdraw from the research at any time and for any reason?	**X**		
6.	With questionnaires, will you give participants the option of omitting questions they do not want to answer?			**X**

7.	Will you tell participants that their data will be treated with full confidentiality and that, if published, it will not be identifiable as theirs?	**X**		
8.	Will you debrief participants at the end of their participation (i.e. give them a brief explanation of the study)?	**X**		

If you have ticked 'No' to any of Q1-8, you must ensure that the reasons for this are made explicit in your project proposal [note n/a = not applicable]

		YES	**NO**	**N/A**
9.	Will your project involve deliberately misleading participants in any way?		**X**	
10.	Is there any realistic risk of participants or researchers experiencing either physical or psychological distress or discomfort? If yes, give details on a separate sheet and state what you will tell them to do if they should experience any problems (e.g. who they can contact for help).		**X**	

If you have ticked 'Yes' to Q9 or Q10, you should ensure that your proposal describes in sufficient detail the appropriate procedures and provides a scientific justification for their inclusion. You should also identify alternative methodologies and outline the reasons why they were deemed inappropriate.

			YES	**NO**	**N/A**
11.	Does your project involve work with animals**? If yes, you should also investigate whether you require approval from the S.A. Health Professions Council and/or related organisation. Provide the answer to this in your Proposal.**			**X**	
12.	Do participants fall into any of the following groups**? If they do, refer to professional body guidelines and include some reference to these in your proposal.**	Children (under 16 years of age)		**X**	
		Schoolchildren of all ages		**X**	
		People with learning or communication difficulties		**X**	
		Patients		**X**	
		People in custody		**X**	
		People engaged in illegal activities (e.g. drug taking)		**X**	
				YES	**NO**
13.	Does your study include administering a Psychometric test(s)? **If yes, name the test (s) and describe your or your supervisor's competence to administer such tests.**				**X**

		YES	NO
14.	Will your study involve *any* contact with *any* external institution**? If yes, your proposal will not normally be approved unless you submit a letter of confirmation from the person responsible for this institution that they are happy for you to conduct your study on their premises and/or contact their staff and/or people who use the service.**	**X**	
NB: The lead researcher and/or supervisor is obliged to bring to the attention of the Faculty of Business Ethics Committee any ethical issues.			

PLEASE TICK **EITHER** Statement **A** OR Statement **B** BELOW **AND PROVIDE THE DETAILS REQUIRED.**

Statement A: I consider that this project has **NO** significant ethical implications.	**X**
Statement B: I consider that this project may have ethical implications that should be carefully considered by the Faculty of Business Ethics Committee, as it deals with ethically sensitive issues e.g. research involving vulnerable populations. **If you select this statement ensure that you provide the methods and/or evidence that will address the ethical issues in your proposal, and furthermore that you are willing to avail yourself for an oral presentation of your study to the ethics committee.**	
If you ticked Statement B you must provide all the information listed: 1. Your name and title of project 2. Purpose of project and its academic/scientific rationale 3. Full description of methods and measurements 4. Participants: recruitment methods, number, age, exclusion/inclusion criteria 5. Consent and participant information arrangements, debriefing. Please attach intended information and consent forms 6. A clear but concise statement of the ethical considerations raised by the project and how you intend to deal with them 8. Estimated start date and duration of project	

I understand the Cape Peninsula University of Technology Guide to Post Graduate Studies and Guidelines for Research Proposals and to the best of my knowledge have complied with the ethical requirements for research.

Lead Researcher

Signed: 

Print Name: Ntombifikile Fortunate Mposula

Student Number: 215275969

Date: 24 April 2015

Cape Peninsula
University of Technology

P.O. Box 1906 • Bellville 7535 South Africa •Tel: +27 21 6801680 • Email: saliefa@cput.ac.za
Symphony Road Bellville 7535

Office of the Chairperson Research Ethics Committee	Faculty: **BUSINESS**

At a meeting of the Research Ethics Committee on 16 September 2015, **Provisional Ethics Approval was granted to** MPOSULA, NTOMBIFIKILE (215275969) **for research activities Related to the MTech/DTech**: MTech: BUSINESS INFORMATION SYSTEMS **at the Cape Peninsula University of Technology**

Title of dissertation/thesis:	Gamification as a tool for developing critical thinking amongst ICT students at a tertiary institution in South Africa Supervisor: Dr A De La Harpe

Comments:

Decision: PROVISIONALLY APPROVED

Signed: Chairperson: Research Ethics Committee	**16 September 2015** **Date**
Signed: Chairperson: Faculty Research Committee	25 September 2015 **Date**

Clearance Certificate No | 2015FBREC287

I Prof. P.H. Omara-Ojungu, in my capacity as Campus Principal at the Ekurhuleni Campus of the Vaal University of Technology give consent in principle to allow Ntombifikile Fortunate Mposula (215275969), a student at the Cape Peninsula University of Technology, to collect data in this company as part of her M Tech (IT) research. The student has explained to me the nature of her research and the nature of the data to be collected.

This consent in no way commits any individual staff member or student to participate in the research, and it is expected that the student will get explicit consent from any participants. I reserve the right to withdraw this permission at some future time.

In addition, the company's name may or may not be used as indicated below. (Tick as appropriate.)

	Thesis	Conference paper	Journal article	Research poster
Yes	x	x	x	x
No				

_____05 May 2015_____

APPENDIX G: LANGUAGE EDITING CERTIFICATE

19 October 2019

NTOMBIFIKILE FORTUNATE MPOSULA
Faculty of Business and Management Sciences
Cape Peninsula University of Technology
Cape Town

RE: CERTIFICATE - TECHNICAL EDITING AND PROOFREADING OF MTECH THESIS

I, the undersigned, herewith certify that the technical editing and proofreading of the MTech thesis of Ntombifikile Fortunate Mposula, titled *"GAMIFICATION AS A TOOL FOR DEVELOPING CRITICAL THINKING AMONG ICT STUDENTS AT A TERTIARY INSTITUTION IN SOUTH AFRICA",* has been conducted and concluded.

The finalised document was submitted to Ntombifikile on 19 October 2019 and cc'd to Prof André de la Harpe.

Sincerely

Professor Annelie Jordaan
DTech: Information Technology
Ph: 065 990 3713

Member: SATI 1003347

South African Translators' Institute (SATI)