

**APPLYING GAME BASED LEARNING AT THE SOUTH AFRICAN
MILITARY ACADEMY: AN EXPERIMENTAL STUDY**

by

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Declaration

Hereby I, Adriaan Marthinus Francois Dreyer, declare that this study is my own original work, that all sources have been accurately acknowledged and that this document has not previously in its entirety or in part been submitted at any university to obtain an academic qualification.

Adriaan Marthinus Francois Dreyer

March 2017

Abstract

The contemporary military environment is characterised by new technologies, advances in computer usage, and a younger generation of students who have the expectation that the use of technology within education is going to increase over the next few years (McClarty, et al., 2012, p. 2). The educational environment is becoming more reliant on technology to help facilitate teaching. Within higher education there are theoretical reports suggesting that games within education can be a feasible solution for supplementing traditional teaching practices in a positive manner, making the learning more interactive and enjoyable for students (Gee, 2011; Annetta, 2008; Borokhovski, Bernard, Tamim, Schmid, & Sokolovskaya, 2016). Although there is much theoretical support for the use of games within education, there is mixed empirical support for the successful use of thereof.

The aim of this study is to investigate whether Game-Based Learning (GBL) will result in higher learning gains when compared to traditional teaching methods; in particular, when used as a method to teach JavaScript to undergraduate Computer Information Systems (CIS) students at the Military Academy (MA) of the South African National Defence Force (SANDF). The study also investigated if GBL can be feasible to use as a teaching method at the MA. A research experiment was conducted to investigate the differences in learning gains between the two afore-mentioned teaching approaches. The difference in learning gain scores were statistically investigated and the necessary conclusions were drawn. From the statistical analysis conducted it should be clear if GBL can be used as a teaching method at the MA. This can only be concluded if the learning gains from GBL are at least as good as the learning gains from the traditional teaching methods.

A sample of 47 (n=47) residential students was used. These students are enrolled in CIS as part of their B. Mil studies at the Faculty of Military Science of Stellenbosch University. Participants were selected from the SA Navy, SA Army, and SA Air Force. Participants were

tested on their JavaScript knowledge using a pre- and post-test designed experiment. Significance testing was done to determine the differences between the variables.

Results reveal no significant difference between the learning gains of the GBL and traditional teaching methods groups. Significant difference in knowledge before and after the study was revealed in both the GBL and traditional teaching groups, indicating both teaching methods are feasible to use as teaching methods at the MA.

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Table of Contents

Declaration.....	ii
Abstract.....	iii
Acknowledgements.....	v
Table of Contents.....	vi
List of Tables	x
List of Figures.....	xi
List of Acronyms and Abbreviations.....	xii
CHAPTER 1	1
1.1. Introduction	1
1.2. Research Problem.....	5
1.3. Research Questions	6
1.4. Research Aim and Objectives	7
1.4.1. Research Aim.....	7
1.4.2. Research Objectives	7
1.5. Dependent and Independent Variables.....	7
1.6. Research Hypothesis	8
1.7. Research Process Overview	9
1.7.1. Phase 1: Literature review.....	9
1.7.2. Phase 2: Research experiment.....	9
1.7.3. Phase 3: Reporting of results.....	10
1.7.4. Phase 4: Discussion of results	10

1.7.5.	Phase 5: Conclusions, limitations and recommendations	10
1.8.	Chapter Overview	11
1.9.	Summary.....	11
CHAPTER 2		12
2.1.	Introduction.....	12
2.2.	Technology in education.....	12
2.3.	The Digital Divide in South Africa	14
2.4.	Theories of Learning.....	16
2.4.1.	Learning defined	16
2.4.2.	Different methods of learning	19
2.4.3.	Adult Learning	21
2.4.4.	E-learning and Blended Learning	24
2.4.5.	Evaluation and assessment of learning.....	27
2.5.	Traditional teaching methods	29
2.6.	Games in education.....	31
2.6.1.	Definitions and motivation.....	31
2.6.2.	Advantages and Disadvantages of games in education	34
2.6.3.	Teaching with games.....	37
2.7.	Game-based Learning (GBL) in education.....	41
2.7.1.	Benefits of GBL	43
2.8.	Games and the Military	46

2.9.	Summary.....	48
CHAPTER 3		49
3.1.	Introduction.....	49
3.2.	Research phases	50
3.3.	Research design	53
3.4.	Measuring instruments.....	54
3.5.	Sampling design.....	54
3.6.	Code Combat	57
3.7.	Materials	58
3.8.	Procedure	59
3.9.	Statistical analysis.....	60
3.10.	Summary.....	60
CHAPTER 4		61
4.1.	Introduction.....	61
4.2.	Descriptive statistics of the sample.....	61
4.3.	Validity and reliability of questionnaires	62
4.3.1.	Validity	62
4.3.2.	Reliability testing.....	62
4.4.	Learning Gain Scores for the groupings.....	63
4.4.1.	Gain scores for group 1 - control	63
4.4.2.	Gain scores for group 2 - GBL.....	64

4.4.3.	Gain scores for group 3 – traditional teaching	66
4.5.	Significance testing.....	67
4.5.1.	Group 1 – Control	67
4.5.2.	Group 2 - GBL	68
4.5.3.	Group 3 – Traditional teaching	69
4.5.4.	Differences between group1 and group 2 gain scores.....	71
4.5.5.	Differences between group 1 and group 3 gain scores.....	73
4.5.6.	Difference between group 2 and group 3 gain scores	75
4.5.7.	Differences between the control, GBL, and traditional teaching group.....	76
4.5.8.	Hypothesis of the study	78
4.6.	Summary.....	79
CHAPTER 5		81
5.1.	Introduction.....	81
5.2.	Discussion on gain score results	81
5.3.	Discussion on significance testing.....	83
5.4.	Summary.....	85
5.5.	Conclusions.....	85
5.6.	Limitations	87
5.7.	Recommendations.....	88
References.....		92

List of Tables

Table 1. Grow's 4-stage Model for the Different Types of Students	23
Table 2. Research Experiment Groups.	51
Table 3. Gain Scores for Group 1.	64
Table 4. Gain Scores for Group 2.	65
Table 5. Gain Scores for Group 3.	66
Table 6. Descriptive Analysis of Pretest and Posttest Scores for Group 1.	67
Table 7. ANOVA for the Difference in Pretest and Posttest Scores of Group 1.....	68
Table 8. Descriptive Analysis of Pretest and Posttest Scores for Group 2.	68
Table 9. ANOVA for the Difference in Pretest and Posttest Scores of Group 2.....	69
Table 10. Descriptive Analysis of Pretest and Posttest Scores for Group 3.	70
Table 11. ANOVA for the Difference in Pretest and Posttest Scores of Group.....	70
Table 12. Descriptive Statistics for Group 1 and Group 2.	71
Table 13. ANOVA for the Difference in Learning Gain Scores of Group 1 and Group 2.	72
Table 14. Descriptive Statistics for Group 1 and Group 3 Learning Gain Scores.....	73
Table 15. ANOVA for the Difference in Learning Gain Scores of Group 1 and Group 3.	74
Table 16. Descriptive Statistics for Group 2 and Group 3 Learning Gain Scores.	75
Table 17. ANOVA for the Difference in Learning Gain Scores of Group 2 and Group 3.	75
Table 18. ANOVA for the Difference in Learning Gain Scores of Group 1, Group 2, and Group 3.....	77
Table 19. Tukey's HSD test for difference in samples.....	77

List of Figures

Figure 1. Independent and Dependent Variables.	8
Figure 2. Different Phases of the Study.	52
Figure 3. Group 1 and Group 2 Gain Scores.	72
Figure 4. Group 1 and Group 3 Gain Scores.	74
Figure 5. Group 2 and Group 3 Gain Scores.	76
Figure 6. Group 1, Group 2, and Group 3 Gain Scores.....	78

List of Acronyms and Abbreviations

GBL	Game Based Learning
CIS	Computer Information Systems
SANDF	South African National Defence Force
MA	Military Academy
SAA	South African Army
SAAF	South African Air Force
SAMHS	South African Military Health Services
SAN	South African Navy
US	University of Stellenbosch
ANOVA	Analysis of Variance
SD	Standard Deviation
M	Mean
KR20	Kuder-Richardson-20
HSD	Honestly Significant Difference
LAN	Local Area Network
F2F	Face-to-Face

CHAPTER 1

INTRODUCTION

1.1. Introduction

Within modern society it is considered unacceptable to be uneducated (Marshall, 2016, p. 288). Value is given to education within modern society because an educated population can adapt to modern practices. A well-educated population can use technological tools for business and to take industry forward, which is essential for the well-being of an academic institution and the nation (Marshall, 2016, p. 288).

The SANDF faces the universal challenge of building and sustaining an educated military. This challenge can only be addressed if the higher education institutions like the MA keep up with global standards and efforts of using technology in higher educational environments.

The relationship between higher education and technology is ever changing and complex. Within the twenty first century, technology is playing a vital role in the facilitation of learning in higher education and its importance in is increasing all the time (Cant & Bothma, 2010, p. 56). The technologies used in education are many, ranging from learning management systems, email, compact discs, mobile wireless technologies, etc. (Cant & Bothma, 2010, p. 56).

Although institutions of higher learning have made significant investments in new technological tools, research has revealed that the relationship between technology and education is not as straightforward as it may appear (Knight, 2009, p. 7; Flavin, 2016, pp. 3-4). Decisions about selecting the most effective technology to use, in an ever-changing industry, are complex and challenging (Knight, 2009, p. 5).

The main reason for doing so is to constantly be adapting to the new generation of students, their skillset, and the way they learn. Introducing new pedagogical models to the

current educational curricula can change the learning experience of students and can be used to address the ever-changing learning technological landscape in a positive way (Marshall, 2016, p. 289).

Learning is taking place in a way that was not foreseen in the early 21st century, a way that is different from any previous ways of learning (Knight, 2009, p. 5). The use of Information Technology and ownership of personal technologies is common amongst higher education students. This is especially true for the younger students who embrace technology, which result in technology being deeply embedded in their daily lives (Knight, 2009, p. 6). This contributes to students being more dependent on technology (see par 2.2) to help them fit learning into their complicated daily lives.

Because of the unique situation modern society has entered, educators are faced with a rather unique challenge: they must stay up to date with the rapidly changing technology which in a way has put the focus on the pedagogic skills of the educator (Knight, 2009, p. 5). Furthermore, educators need to understand technology to evolve their skills as teachers. The key to being successful in reaching students is to integrate the technology most suited for their purpose (Knight, 2009, p. 7). A skilful combination of traditional and more innovative teaching strategies should be used to engage and encourage learners to be more participative, and interactive (Knight, 2009, p. 9).

Student interaction during the learning experience is widely regarded as fundamental in today's classroom (Borokhovski, Bernard, Tamim, Schmid, & Sokolovskaya, 2016, p. 16). Students do not respond well to long, boring, uninteresting lessons (see par 2.4) (Ballance, 2013, p. 218). Students will only interact with fellow classmates and the subject matter if they are mentally engaged within the classroom (Borokhovski, et al., 2016, p. 16). Technology plays a vital role in engaging students. Students with different needs and learning styles will learn

more if the educator knows how to keep them interested and engaged during the learning experience (Knight, 2009, p. 9).

Students today are growing up with technology at their fingertips. Internet searches can be done by a simple touch of a button and live streaming anything over social media is done with ease (Palfrey & Gasser, 2008, p. 1). Students have devices (e.g. smartphones or tablets) that they use for listening to music, sending messages, keeping up to date with what is happening in the world, and conversing over social media.

This exposure to Information Technology, from a very young age, alters the way that these students process information, and the way they learn or want to be taught. They must be intellectually challenged to understand and practice what they have learned (Palfrey & Gasser, 2008, pp. 2-4).

Traditional teaching requires students to learn “facts” and to repeat these “facts” during an examination, but does not ensure they are able to apply what they have learned to solve problems or understand the area that they are learning. This is because they never apply what they have learned (Gee, 2007, p. 113). The retention of knowledge only happens once the person can apply what they have learned; learning facts without applying what has been taught is trivial (Gee, 2007, p. 114). The Information Age has enabled students to be part of the learning process instead of merely being the recipients of the teachings of others. Moreover, students are more engaged with the information and need to interact with the subject matter to bring meaning to the learning experience.

Students do not all have the same reaction to a single point of stimulus. Institutions have noticed this and know that people learn best by using a combination of different teaching methods or learning techniques (see par 2.4.2) (Hilton, 2006, p. 14). Students at the MA are all adult students and this changes the dynamic of the learning that takes place and forces the educator to adapt to the current classroom setup (see par 2.4.3). Skilled educators are able to

use this knowledge and different classroom dynamics to enhance the way they teach, by using different teaching methods and approaches.

One such approach is the use of e-learning to facilitate the learning within the classroom and outside the classroom. E-learning entails the use of technologies within teaching and is delivered by use of computers or devices. This is a learning technique that is aimed at better student engagement and interaction. It has become the most applied teaching method to supplement face-to-face (F2F) education (see par 2.4.4). Although e-learning is widely used, it may not always be the answer that the educators need to better their teaching approach. Thus, educators have also been using blended learning to help better the learning taking place in the classroom. With the blended learning approach educators have the chance to teach using a combination of F2F and computer aided teaching method (O'Byrne & Kristine, 2015, p. 137).

Similarly, GBL (see par 2.7) has been used to help keep students interested and engaged in the work. Different learning theories point to the potential games have to motivate, engage, and provide an authentic learning experience to the student (Chmiel, 2015). GBL keeps the student engaged and interested in the subject matter. GBL is most appropriately used when integrated into a well-designed learning experiences that can benefit from game-design principles. The 2011 Horizon report suggests that GBL will gain widespread use within the next few years (Johnson, Smith, Willis, Levine, & Haywood, 2011). A well-designed lesson plan that includes a GBL part can provide increased levels of interaction that a student may need for learning to take place.

This can only be made possible if the educators can integrate technology in their teachings effectively and in such a way that students can interact and engage with the learning materials to improve the learning experience. If GBL and the use of technology within education does not improve the learning experience for the student, by making it more interactive, then the implementation of such teaching tools should not proceed.

The beneficial effects of GBL has been well documented within literature (see par 2.7.1), thus the study will not try and argue why GBL should be used for education. Rather, the study focusses on learning gains achieved when using GBL (see par 2.7), within a university setting, as a method of teaching. The study investigates if GBL can be used effectively, and if the use of GBL creates a more engaging, relevant learning experience. Furthermore, tests to measure if GBL is a well-suited teaching method for higher education at the MA were conducted.

Given the limited research on GBL within the SANDF, this study adds to existing literature by investigating GBL and traditional teaching methods as applied at the MA. This study will create awareness within the MA that GBL is indeed a teaching method used internationally and can be used within the SANDF higher educational context. The study highlights the possible use of GBL within the MA, especially within CIS modules and the enrichment GBL can have on the MA students' learning experience. Due to GBL being a more engaging, interactive, and motivating way to learn new subject matter, a significant difference in the learning gains of GBL and traditional teaching methods was expected.

This chapter provides the reader with the objectives, background, and motivation for the study. Secondly, it describes the theoretical background of the study and state the research problem, research questions, the aim and objectives of the study and hypothesis. This chapter also includes the research process overview, and the chapter overview.

1.2. Research Problem

Given the continually shrinking military training budgets, SANDF practitioners must allocate time and funds in such a way that knowledge acquisition and retention is optimised (Ricci, Salas, & Cannon-Bowers, 2002, p. 295). For this reason, the SANDF has been using simulators to train soldiers and pilots effectively in the use of vehicles as well as warfare drills and movements. Thus, it is no surprise that the MA has been using GBL as a way of teaching students in the aeronautical science modules (Stellenbosch University, 2013). At the moment,

the aeronautical science modules are the only modules utilising GBL. GBL has been proven to be feasible and effective within these modules, but no other module within the MA has used GBL yet. The obvious conclusion is that GBL is underutilised within the SANDF and specifically at the MA. The technological innovations within education is an opportunity for the SANDF to be more cost effective and to extend the research and academic value of the higher educational institutes such as the MA.

While the traditional teaching methods at the MA are still appropriate, there are advantages to both lecturers and students if these methods are supplemented by GBL, such as higher gains score when used to teach undergraduate Computer Information Systems (CIS) students at the MA. A good educational game may be able to teach a student in a way that a lecturer never can (Gee J. P., 2009, pp. 67-69). Therefore, investigation into the potential effects that GBL may have on the learning gains of a residential undergraduate CIS student at the MA is needed.

Calculation of the learning gain scores for every student is an effective way to test if GBL can be an effective teaching tool within the MA. Learning Gain is understood as the difference in performance of students in different stages of education (McGrath, Guerin, Harte, Frearson, & Manville, 2015, p. 45). This study was conducted to investigate whether GBL can be used as a supplementary teaching method for CIS students at the MA or not.

1.3. Research Questions

The research questions are derived from the research problem. The study was conducted to answer the following questions:

1.3.1. Does GBL result in significantly higher learning gains than traditional teaching methods?

1.3.2. Can GBL be used effectively as a teaching method at the MA?

1.4. Research Aim and Objectives

1.4.1. Research Aim.

To test if GBL will result in higher learning gains of a CIS student at the MA than traditional teaching methods.

To validate if GBL can be used as a teaching method at the MA, within the context of an undergraduate program.

1.4.2. Research Objectives

1.4.2.1. To measure if GBL result in higher learning gains than traditional teaching.

1.4.2.2. To determine if GBL has a positive effect on the learning gains and experience of students at the MA.

1.4.2.3. To determine if GBL can be used as a supplementary teaching method to traditional teaching at the MA.

1.5. Dependent and Independent Variables

This study used an experimental approach to determine the learning gains of the participants using different methods of teaching. The independent variables for this study are the two teaching methods used namely GBL, and traditional teaching. Also within this study there are three factors that influence the learning gains of participants through GBL: self study, no lecturer intervention, and the game played (Code Combat). Traditional learning includes the following factors: lecturer taught the work, regular contact sessions with the lecturer. Student learning gains defined by the participants' learning gain scores is the dependent variable. The conceptual model outlined in figure 1 depicts the possible relationship among the variables.

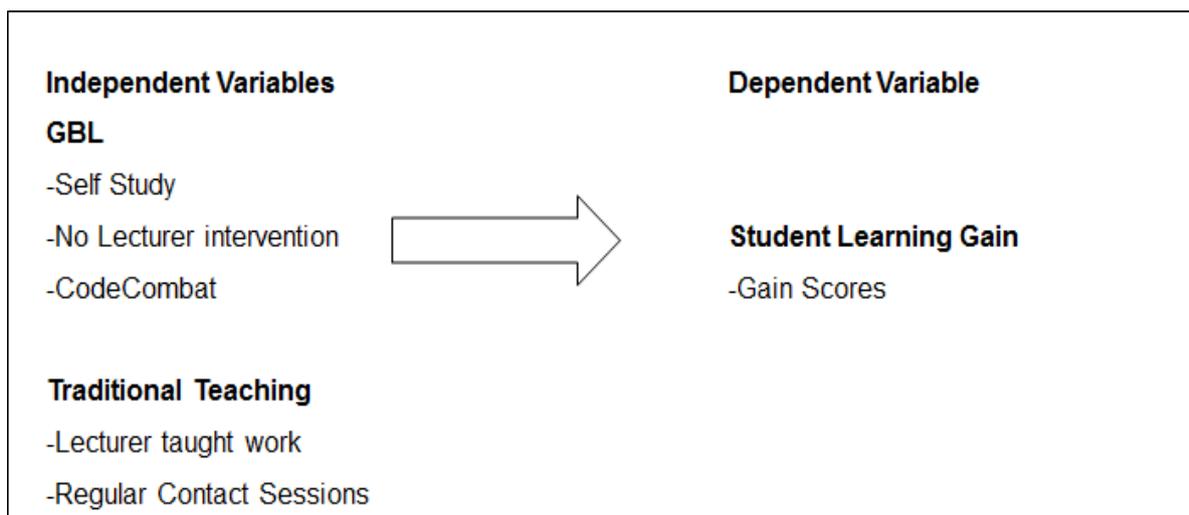


Figure 1. Independent and Dependent Variables.

1.6. Research Hypothesis

Based on the aim of the study, the following research null and alternative hypothesis can be drawn:

1.6.1. H0: Game Based Learning does not result in significantly higher learning gains than traditional teaching.

1.6.2. H1: Game Based Learning results in significantly higher learning gain scores than traditional teaching.

1.6.3. H0: There is no significant positive gain in knowledge when GBL is used as teaching method.

1.6.4. H2: There is a significant positive gain in knowledge when GBL is used as teaching method.

1.6.5. H0: There is no significant positive gain in knowledge if traditional teaching is used as a teaching method.

1.6.6. H3: There is a significant positive gain in knowledge if traditional teaching is used as a teaching method.

1.6.7. H0: There is no significant difference in the traditional teaching and GBL learning gain scores.

1.6.8. H4: There is a significant difference in the traditional teaching and GBL learning gain scores.

1.7. Research Process Overview

The research was conducted in 5 phases, namely the literature review, the research experiment, reporting of the results, discussion of the results, the conclusion, limitations and recommendations of the research.

1.7.1. Phase 1: Literature review

The focus of the literature review is to delineate what learning is and to present different factors that influence the learning experience of a student. Furthermore, the literature review describes GBL and its current and future usage within higher educational. The literature review is the theoretical basis upon which the study is conducted.

Specific areas of the literature review include:

- Theories of Learning including adult learning, different methods of learning such as classical conditioning, operant conditioning, cognitive learning, etc.
- The aspects of learning that can be addressed by using GBL to teach CIS students at the MA.
- Games in education.
- The use of GBL in education.
- GBL within the military and specifically in the SANDF.

1.7.2. Phase 2: Research experiment

A questionnaire was used to gather data for this research. The questionnaire was a paper-and-pencil test. The questionnaire was reviewed by the Stellenbosch University ethics committee for approval and was reviewed by CIS lecturers at the MA. The experiment required

three participant groupings, namely the control group, the GBL group, and the traditional teaching group. The GBL group and the traditional teaching group participated in a learning intervention. Learning gain scores were measured using the gain score formula (see par 3.7). Only the test scores and the learning gain scores were used for analysis. Emphasis was placed on the quantification of the data obtained through the research experiment and used to formulate the descriptive statistics that will be the outcome of the study.

1.7.3. Phase 3: Reporting of results

The various statistical techniques used to analyse the data are discussed in this section. Learning Gain scores were calculated using percentages. Summary statistics were reported using percentages of participants, means, minimums, maximum and standard deviations. To test whether any difference in test scores are significant, single factor analysis of variance was conducted. A five percent significance level ($p < 0.05$) was used as guideline for significant relationships.

1.7.4. Phase 4: Discussion of results

The main results, the explanations of the research, and the outcome of the research experiment are discussed. These results are necessary to conclude if the learning gains from GBL are higher than that from traditional teaching methods. The null and alternative hypothesis of the study will be accepted or rejected in line with the results obtained.

1.7.5. Phase 5: Conclusions, limitations and recommendations

The research experiment, the general limitations of the research and the research conclusions are discussed. Recommendations are presented for future research, on how the results can be used and on ways for the SANDF and the MA to move forward with GBL as teaching method.

1.8. Chapter Overview

- Chapter 1: Introduction and Rationale
- Chapter 2: Literature Review
- Chapter 3: Research Design and Methodology
- Chapter 4: Results
- Chapter 5: Conclusions, Limitations, and Recommendations

1.9. Summary

The importance and motivation for the study has been presented in this chapter. Many industries have been revolutionised by the use of technology in an industry changing manner. Industries such as: commercial agriculture, the manufacturing process of goods and mobile communication technology have changed in a way that they can no longer function without the use of modern technology. The use of technology in education is increasing evermore, indicating that education is poised for a similar technological revolution that will change the educational landscape forever. Higher education today is evolving and students are more inclined to use technology. Adequate skills and competencies from educators are necessary to ensure the success of our education system. Educators should present more interactive learning and engaging curricula to students.

The study aims to show that GBL can be used as a teaching method at the MA and therefore within the SANDF. The next chapter will present the literature review where the main concepts of the study are discussed in detail.

CHAPTER 2

LITERATURE REVIEW

2.1. Introduction

The purpose of the study is to investigate the difference in learning gain scores achieved using two different methods of teaching namely, GBL and traditional teaching methods. The study is specifically focused on higher education, particularly on the Military Academy undergraduate CIS students. The literature is reviewed in the following order: technology in education, the digital divide, theories of learning, traditional teaching methods, games in education, GBL and then games and the military. Video games and gaming is discussed in terms of its use in teaching at a tertiary level as well as within the military environment. Given the ever-changing technological environment, educators must stay up to date with technology to remain effective educators, because of student needs and expectations. This can be a challenge.

2.2. Technology in education

“Training the workforce of tomorrow with today’s schools is like trying to teach kids about today’s computers on a 50-year old mainframe.” – Bill Gates

The rapid permeation of increasingly sophisticated technologies into every facet of society is causing significant shifts in how we live, work, organise our lives, and how we process data (McClarty, Orr, Frey, Dolan, Vissileva, McVay, 2012, p. 1). Today’s generation of students are growing up immersed in a technology driven, media-rich world. Younger students generally embrace new technology and have high expectations of using technology at a tertiary level of education (Knight, 2009, p. 6). The new generation of students are more technologically advanced when compared to their previous cohorts, and expect this same level of understanding from educators. Knight (2009), further notes that the “link between technology and the enhancement of learning and teaching is well established” and technology

is deeply embedded in the lives of learners (p. 6). Skills needed to be successful goes well beyond what students learn, and are more focused on how and when they learn (McClarty, et al., 2012, p. 4)

The challenges imposed by the rapid change in technology within society are significant, and an imparted technological knowledge base because of inadequate education is no longer acceptable (McClarty, et al., 2012, p. 3). Educators, as is the case with students, must adapt to the rapidly changing technologies. Some educators are technologically challenged and either shy away from using technologies in their teaching activities, or need to be taught how to use the new technology before they can incorporate it into their teaching methods (Cant & Bothma, 2010, p. 56). Other educators are more comfortable with the use of technology within their teaching and thus they go to extra lengths to include technology in their teaching (Cant & Bothma, 2010, p. 56). This unilateral use of technology often results in uneven and inconsistent teaching.

Technology plays a vital role in the facilitation of learning in higher education and the importance of technology in the education environment is increasing evermore (Cant & Bothma, 2010, p. 56). Typical technologies such as overhead projectors, radios, televisions, computers, the Internet, etc. have been employed within education (McClarty, et al., 2012, p. 7). However, the skills of the educators who use them remain the key to the effectiveness of the learning taking place, an unchanging factor in a context of a rapidly changing educational environment (Knight, 2009, p. 7).

One area that looks promising in this regard is the use of games in education (McClarty, et al., 2012). As technology advances, game developers increasingly find ways to make gameplay more realistic and entertaining. Video games have changed the way that young people socialise and communicate (Annetta, 2008, p. 230). The video game industry faces a well-known problem; if they do not teach the player how to master the skills within the game

no one will play it, or even buy it. Thus, game developers have become very good at employing teaching and learning strategies in their designs (Gee, 2009, p. 72). As a result, serious attention has been given to developing games for education and incorporate it within education (Annetta, 2008, p. 231).

2.3. The Digital Divide in South Africa

There are a few things to consider before one can incorporate such a technology-heavy teaching method within any educational setup in South Africa. This is especially true in South Africa where many students are from rural areas and from poor communities where technology is not as widely used as in the suburbs and metropolises (Bornman, 2016, p. 264). The “digital divide” describes a disparity in the use of Information Technology and the Internet, by those who have access to digital technology and the Internet and those who do not (Singh, 2004, p. 4). Singh (2004) state that the term digital divide “refers to the inequalities between individuals, households, businesses, or geographic areas” (p. 5).

The digital divide as experienced in South Africa is mainly attributed to the high levels of poverty, illiteracy, lack of telecommunication infrastructure, and high cost of connectivity within the country (Singh, 2004, pp. 6:7; Bornman, 2016, p. 268). The digital divide is not just a product of the difference between first and third-world countries or rich and poor (Singh, 2004, p. 6). Several factors such as gender inequality, physical disability, racial segregation and politics have a big influence on the stance of the digital divide on a national and local level (Bornman, 2016, pp. 266-267). The digital divide is a twofold problem and exists on two distinct levels: a macro and micro level.

The macro level refers to the physical infrastructure that is not always in place to enable students to use technology (Singh, 2004, p. 4). The problem expands much further than just hardware and software; politics have become one of the biggest issues faced in developing countries (Singh, 2004, p. 6). Civil unrest and poverty as well as the low level of literacy, along

with politicians in many developing countries hinder the ability to narrowing the digital divide (Bornman, 2016, p. 268 & Singh, 2004, p. 6).

On a micro level, the digital divide manifests itself in organisations where people are trained and schooled (Singh, 2004, p. 6). Many older academics do not want to use the technology or just do not know how to use new technology and this impacts on the students and effects their information literacy to a large extend (Singh, 2004, p. 7). Some students may experience techno-phobia because of a lack of experience (which puts them behind other students), or because they had no prior exposure to a certain type of technology. Students from rural areas or poor backgrounds are not always able to keep up with students who had access to telecommunication infrastructure from a young age.

Although the digital divide is a large obstacle that has yet to be overcome, many steps are being taken to upgrade the infrastructure of technology centres and digital villages in townships and rural areas (Bornman, 2016, pp. 268-269). These steps will in future enable South Africa to bridge the gap that exist and thus students will already be comfortable with using technology to study by the time they become tertiary students (Singh, 2004, p. 9).

Many students at the MA come from a disadvantaged background with minimal computer skills and minimal technology knowledge. This negatively influences their potential to be successful in their studies. In order to try and bridge the gap that exists between students at the MA, all first-year students are enrolled in a module called Information System Theory and Practice (Stellenbosch University, 2013, p. 44). Within this module, students are taught computer literacy which includes computer basics, as well as Microsoft Office and Computer Ethics (Stellenbosch University, 2013, p. 45). This module is in place to ensure that all students at the MA have higher levels of computer literacy at the end of the first semester, which in turn helps to narrow the existing gap between students due to the digital divide.

One implication of the digital divide at the MA is that the population appropriate for the study was smaller than the actual population of students at the MA. For this reason, the study focused on CIS students that already completed the first part Information System Theory and Practice module successfully.

2.4. Theories of Learning

“Tell me and I’ll forget. Show me, and I may remember. Involve me and I’ll understand.” - Xun Zi (Scarborough, 2013).

When education is not interactive and engaging, learning potential is degraded (Ballance, 2013, p. 218). Student engagement highly correlates with learning and personal development, and has become a much-studied research topic within higher education (Porter, 2006, p. 521). Carini et al. (2006) state that student engagement is generally considered to be among the better predictors of learning and personal development (p. 2). Student engagement is therefore a good predictor of the amount of learning that will take place. Carini et al. (2006) further state that being engaged during the teaching process adds to the foundation of skills and dispositions that are essential for developing habits that enlarge the learner’s capacity for continuous learning and personal development (p. 2). Thus, the more students are engaged within a subject and the more they study a certain subject the better they will know the subject matter, which in turn can lead to a better understanding thereof, even after they graduate university (Carini, et al., 2006, p. 3).

Therefore, this study investigates whether GBL (an engaging activity) will result in higher learning gain scores than when students are taught using traditional teaching methods.

2.4.1. Learning defined

To ascertain whether GBL result in learning gains, or not, it is necessary to understand learning. There are many different definitions for learning as a concept, and without an implicit

sense of what learning is, there would be no reason to study it (De Houwer, Barnes-Homes, & Moors, 2013, p. 630).

Within the literature, the most prevalent definition is that learning is a relatively permanent change in behaviour that occurs as the result of practice and experience (Chimbwanda, Dodd, Naik, & Tebele, 2010; De Houwer, et al., 2013, p. 631; Goldstein & Ford, 2002). Buckley et al. (2006), state that learning entails the acquisition of new information regardless of whether it is ever used or displayed. (Buckley & Anderson, 2006, p. 367). Weiss, (as cited in Goldstein & Ford, 2002) defines learning as “a relatively permanent change in knowledge or skill, produced by experience” (Goldstein & Ford, 2002, p. 172). The authors give roughly the same definition of learning, and state that learning constitutes a change in behaviour of the person. Most textbooks define learning as a change in behaviour (De Houwer, et al., 2013, p. 632). This change may manifest itself as a physical change such as the way a person behaves, but it may also manifest as a difference in the way a person thinks, which, in turn, contributes to the change in behaviour (De Houwer, et al., 2013, p. 633).

Kirkpatrick (1996) defines learning in two ways. Firstly, as “the principles, facts and techniques that can be understood and absorbed by training” (pp. 55:56). Secondly, as “a measurement of knowledge acquired, skills improved, or attitudes changed due to training” (Kirkpatrick, 1996, p. 56). Through his definitions Kirkpatrick implies that learning takes place when an individual can apply what is taught either through training or being taught formally in a classroom setup (Kirkpatrick, 1996). This indicates that learning may contribute to a change of behaviour but will not necessarily result in a permanent change of the individuals’ behaviour as stipulated by De Houwer et al. (2013).

Many within the literature (Derek Stockey, 2015; EdTechReview, 2015; De Houwer, et al., 2013, p. 632) see such simple definitions of a concept as broad as learning as unsatisfactory. They argue that learning cannot just be classified or attributed to a single concept or factor, but

it is notoriously difficult to define concepts in a satisfactory manner, especially when concepts are as broad and abstract as the concept of learning (De Houwer, et al., 2013, p. 633:634). All the above-mentioned definitions are essentially very basic and articulate learning as a function that maps experience into behaviour but have difficulties dealing with the fact that changes in behaviour are neither necessary nor sufficient for learning to occur (De Houwer, et al., 2013, p. 633).

De Houwer et al. (2013) define learning as “changes in behaviour of an organism that are the result of regularities in the environment of that organism” (p. 633). This definition also has definitional issues but is sufficient to use as a working definition for learning within this study.

Learning is knowledge often acquired through formal or even advanced schooling. In the formal tertiary context, learning often takes place in class or during lectures. Ballance (2013) states that “Learning as a concept does not mean rote memorisation or clicking through pages to complete a web course; it means either acquiring new, or modifying existing knowledge, behaviours, skills, values of preference that may involve synthesizing new information” (p. 218). Learning is not limited to formal schooling; hence, cognitive processes are broader than those taught and tested in school (Henderson, 2005, p. 1). The formal classroom setup is not the only platform where learning can take place; learning is an ongoing process, which carries on throughout our lives (Chimbwanda, et al., 2010, p. 69).

Not all changes in behaviour are due to learning. Thus, not all changes in behaviour can be attributed to instances of learning (De Houwer, et al., 2013, p. 634). This definition does not imply that changes in behaviour are sufficient to infer the presence of learning, learning only takes place if the change in behaviour is caused by the experience of a person (De Houwer, et al., 2013, p. 634). When working with a concept as broad as learning, the focus point should not just be set on one part of a person’s life, it is important to look at all the aspects thereof

(Chimbwanda, et al., 2010, p. 70:71). Most of the definitions found in literature have the common point of departure; namely that learning involves change within the person, and this change may not necessarily only contribute to a change in behaviour. Learning may manifest as a change in attitude, interest or value. (De Houwer, et al., 2013, p. 630; Chimbwanda, et al., 2010, p. 70).

Although defining a concept as broad as learning is very difficult and many disagree on the exact wording of how to define learning, there is consensus within the literature on how we learn and the processes that are followed (Chimbwanda, et al., 2010, p. 69; De Houwer, et al., 2013, p. 634).

Learning usually triggers change in 3 domains, the cognitive domain, the affective domain and the behavioural domain (Goldstein & Ford, 2002) as cited in (Chimbwanda, et al., 2010, p. 70). Existing skills and knowledge temper the composition of the change within these domains (Chimbwanda, et al., 2010, p. 71). Our existing knowledge along with the newly acquired knowledge integrates, which in turn triggers the relatively permanent change in knowledge, skill, or behaviour (Weiss as cited in Chimbwanda, et al., 2010, p. 71).

This indicates that when student behaviour changes it is not necessarily due to learning that happened at a certain point within the teaching experience. It can be that the student's behaviour changed due to an experience outside the classroom, or during a different learning intervention than what intentionally took place. This is indicative that we all learn through different ways and teaching methods.

2.4.2. Different methods of learning

Per Kirkpatrick, "it is of utmost importance that the amount of learning that takes place is obtained objectively and to be able to quantifiably measure it " (Kirkpatrick, 1996, p. 55). This implies that it is important to measure the knowledge acquired and skills learned from an intervention such as formal training (Dickey, 2011; Kirkpatrick, 1996, p. 56). However, before

one can test the amount of learning that took place, it is necessary to understand the different learning techniques.

While the storing of information and knowledge gained from learning is roughly the same for most people, everyone learns differently. Chimbwanda et al. (2010) discussed some of the learning theories in depth namely; classical conditioning, operant conditioning, and cognitive learning (Chimbwanda, Dodd, Naik, & Tebele, 2010, pp. 72:90).

Classical conditioning involves automatic or reflexive responses; this implies a natural response to a condition (Chimbwanda, et al., 2010, p. 71). Classical conditioning can be applied to all people, as it is one of the ways in which all species learn (McLeod, 2013).

Operant conditioning deals with operant and intentional actions being stimulated by a certain condition (Chimbwanda, et al., p. 73). Operant conditioning as coined by B.F Skinner works on a reward and punishment system as to stimulate good behaviour. In operant conditioning an association is made between a behaviour and a consequence of that behaviour (Cherry, 2016). By using positive reinforcement, desired behaviour is rewarded and thus increases the likelihood of the behaviour to occur again (Chimbwanda, et al., 2010, p. 74). The concept of operant conditioning applies to higher education in the sense that a student that fails a module will get the “punishment” of doing the module over again, where as a student that studies hard will have the “reward” of a Cum Laude for the module.

Cognitive learning works with the thoughts, ideas, beliefs, understanding and knowledge. Cognitive learning opposes classical conditioning and operant conditioning where the subject is just a passive participant. Cognitive learning argues that there is another step between stimulus and response (Chimbwanda, et al., 2010, p. 75). Within cognitive learning, the thinking is that the step in between stimulus and response is a mental effort and a reflective process. To achieve outcomes humans and animals can reflect, adapt and learn through previous experience (Chimbwanda, et al., 2010, p. 75).

This shows that people learn through a variety of ways, learning can also occur outside of formal teaching in a variety of ways; experience, practical implementations, or even self-study. Students can be taught via different methods to achieve their learning outcomes. Thus, educators at universities can use an array of different learning methods and learning pedagogies to teach students.

2.4.3. Adult Learning

All students at the MA are adult learners and therefore it is imperative that the educators understand the way adult learners function. Adult learning as described by Simmons (2007) is the self-driven studying by adults, being younger adults that just started university or adults studying part time after having worked for a few years (Simmons, 2007). Adult learning challenges educators to adapt their teaching methods to fit the general way adults learn (Knowles, 1980, p. 45). Knowles' work on adult learning sets forth several different characteristics of adult learners that lead to educators teaching adult students differently than one would teach child students (Simmons, 2007; Knowles, 1980, p. 47-49).

Knowles (1980) sets forth four main characteristics about adult learners that result in adult learners being taught differently from children. Firstly, adult learners tend to be more self-dependent and self-directed within their studies (Knowles, 1980, p. 46). Secondly, adults bring with them a body of experience that can be beneficial to the classroom and their peers (Knowles, 1980, p. 47). Thirdly, the orientation to learning of an adult learner is influenced by their developmental tasks (Knowles, 1980, p. 48). Fourthly, adult learners need and insist on immediate implementation in their learning (Knowles, 1980, p. 48).

All this leads to the conclusion that the way adults are taught should differ from the way child students are taught (Simmons, 2007). Adults tend to be more self-directed in studying and do not necessarily need as much structure to teachings as non-adult learners would need (Simmons, 2007). This implies that adult learners can be given tasks like playing a GBL game

without constant supervision from the teacher. Knowles (1980), wrote about a “new emphasis on education as a process of facilitating self-directed learning and a redefinition of the role of the educator as a facilitator of self-directed learning and a resource to self-directed learners.” (p. 53). This puts the educators in a role where they are merely facilitating the learning, while the students are mostly self-taught by using several different approaches. Approaches such as GBL and learning that can help facilitate learning. Especially in situations such as the military environment where time is always a factor, and budgets are steadily declining annually. This approach will enable the military to use less costly ways (such as GBL systems) to teach students.

Not all learners are partial to the self-directed teaching methods (Simmons, 2007). In this regard Grow, proposes a model to guide learners to become a self-directed student (Grow, 1991, pp. 127-132). Within this model, Grow acknowledges that all students are different and that educators have to approach every student differently in their teaching methods (Grow, 1991, p. 126). Grow, sets forth a 4-stage model (see Table 1) where he explains the different types of students and what role the educator should play for each type of student.

Table 1 depicts Grow’s 4-stage model in more detail. Stage 1 defines the student as being dependent on the educator and the educator needs to play the role of authority coach, during this stage the educator will teach and discipline the student into learning. During stage 2 the student is the interested party that wants to learn, this gives the educator the freedom to become the motivator or guide in the learning process, guiding the student to set goals and learning strategies. Stage 3 sees the student as involved in the learning process and the educator becomes the facilitator that takes part as the students’ equal. Stage 4 is the final stage of Grow’s model and within this stage the student is a self-directed learner, and the educator is only the consultant or delegator that gives feedback or guidance where needed within the learning process.

Table 1

Grow's 4-stage Model for the Different Types of Students

Stage	Student	Educator	Examples
1	Dependant	Authority Coach	Coaching with immediate feedback. Drill. Informational lecture. Overcoming deficiencies and resistance.
2	Interested	Motivator, Guide	Inspiring lecture plus guided discussion. Goal-setting and learning strategies.
3	Involved	Facilitator	Discussion facilitated by educator who participates as equal. Seminar. Group projects.
4	Self-directed	Consultant, delegator	Internship, dissertation, individual work, or self-directed study group.

Note. Table from (Grow, 1991, p. 129).

Grow's research suggests that students, both adult and children, should be taught in a manner that gradually drives them in the direction of becoming more self-directed (Grow, 1991). Grow also suggests that educators be aware of the difference in the way students learn and the different types of adult students. This will enable educators to adapt their style of teaching and ensure the style of teaching does not clash with the students in such a way that it will prevent learning from taking place (Grow, 1991, p. 128). Furthermore, Grow suggest that within a module multiple teaching styles be adopted to ensure that a variety of student types are included and all students feel engaged in the learning experience (Grow, 1991, p. 127)

In line with Grow's model and Knowles' characteristics it is clear that adult learners can be developed to be self-directed students. Both Grow and Knowles state that all learners are different and different teaching approaches will be the most effective way to reach all learners (Knowles, 1980, pp. 40-59; Grow, 1991, pp. 126-143). This brings to mind the use of e-learning that facilitates learning in an adult learning approach where the students can work at their own

time and pace. This approach is used extensively at the MA and has been endorsed by many universities in South Africa.

2.4.4. E-learning and Blended Learning

When it comes to educating students, the educator will always try to teach a subject in the most interesting way possible to ensure the students stay interested and engaged (Cant & Bothma, 2010, p. 55). For many years, educators have known that people learn best by using a combination of different methods such as observation, questioning, repetition, using initiative and exploring (Hilton, 2006, p. 14). Some students prefer the age-old tradition of sitting in class listening to the lecture and then going through a textbook afterwards, but for others a more interactive environment where one can be taught through interactive activities is a better ideology (Hilton, 2006, p. 15). Because all students learn through different methods, educators must first identify and then provide a method of teaching that best suit the students' needs.

To facilitate student teaching and learning, universities are using e-learning platforms which are built on top of a Learning Management System. At the MA the e-learning platform is called SUNLearn which is built on top of Moodle. E-learning makes use of electronic technologies to provide access to educational content outside of a traditional classroom setting (eLearningNC, 2016); typically via a computer or mobile devices (tablets or smartphones). It is fast becoming the most popular way of conducting training and it allows educators to achieve a great degree of coverage for their target audience, and in a more dynamic fashion than with the conventional teaching setup (Ettinger, Holton, & Blass, 2006, p. 210).

Better student engagement is what higher educational institutes strive for. The search for innovative ways to enhance the learning and knowledge of adult learners is a familiar challenge for educators (Fitzgerald, Bruns, Sonka, Furco, & Swanson, 2012, p. 7). In the last decade, a lot of time and effort was put into promoting and adopting the concept of e-learning (Herselman & Hay, 2005, p. 394).

Despite being a concept originally designed for supporting distance education, today it is mostly applied as a supplementary to F2F education (Herselman & Hay, 2005, p. 395). It has also become an excellent modality for learners to learn online, at their own pace and without any physical boundaries (Herselman & Hay, 2005, p. 396)

For students, e-learning is more enjoyable, the work is more exciting and it keeps the student engaged and interested in the subject matter for longer (Herselman & Hay, 2005, p. 394). Using an array of written words, video, audio, animation, virtual environments, computer simulations, and rich imaging e-learning can achieve the desired knowledge transfer that educators want to achieve (Herselman & Hay, 2005, p. 396).

Furthermore, e-learning is delivered over a vast number of platforms, which include the internet, audio and video conferencing, simulators, handheld devices, Local Area Networks, and many more. Per Herselman and Hay (2005), the most popular of these are still the internet, CD-ROM, and videos (Herselman & Hay, 2005, p. 395).

There have been a few challenges with the acceptance and use of e-learning within schools and academic institutes (Bozalek & Matthews, 2009, p. 236). In a study conducted by Ettinger et al. (2006), it was concluded that the average uptake of e-learning in organisations is much less than originally predicted (p. 209). For many organisations it is difficult to fully implement e-learning and use it to its full potential (Ettinger, et al., 2006, p. 209).

Although e-learning has been used by many institutions and is endorsed by the University of Stellenbosch it should not be the all-encompassing answer to every need that educators and students alike have. It does have its disadvantages and limitations (Herselman & Hay, 2005, p. 397). Many e-learning platforms are outdated and slow. This is counterproductive because it does not promote student engagement, nor does it encourage students to use e-learning (Herselman & Hay, 2005, p. 397).

To improve the student experience and to free up time for educators to have more one-on-one time with their students, educators are also adopting blended – or hybrid learning (Kleber, 2015, p. 21). Blended learning is a pedagogical approach where F2F instruction is combined with computer based media instruction (O'Byrne & Kristine, 2015, p. 137). Kleber (2015) states “Blended learning is a student driven, teacher-supported integration of technology, curriculum and differentiation for individual learning needs” (p. 21).

Blended learning is used as an intermediary tool between traditional F2F classroom education and fully online-hosted modules (O'Byrne & Kristine, 2015, p. 138). This is not just about putting technology in class; it is using this technology to its full potential within the teaching environment. While some classrooms might be technologically rich, the technology does not provide a good blended learning environment by default. Blended learning classrooms focus on some intentional shifts in curriculum, transmission methods, the student/teacher roles, and use of instructional time (Kleber, 2015, p. 21).

Blended learning is a concept strongly endorsed by Stellenbosch University. Within the learning and teaching policy the University is strongly committed to move towards a student centered approach which focusses more on the teaching activities that facilitate learning, rather than the transferring of knowledge from the educator to the students (Stellenbosch University, 2012, p. 2). This coincides with the idea of blended learning where the educator acts as facilitator and mediator within the learning process.

Similarly, GBL in support of traditional teaching may help educators at the MA improve the learning experience of the CIS students in a blended classroom setup. This blended learning approach is student centric, and should result in better student participation within the classroom (Kleber, 2015).

2.4.5. Evaluation and assessment of learning

In 1956, Donald Kirkpatrick created a model called: “Techniques for Evaluating Training Programs.” This model is a well-known model within the literature, and within this model Kirkpatrick described four levels of evaluating a training program. The levels in order of merit are; reaction, learning, behaviour, and results.

Reaction can be defined as how well a particular training program is liked by the people being trained (Kirkpatrick, 1996, p. 55). Within the educational environments it translates to how well the students liked the learning experience. The evaluation of students’ reaction toward the learning experience is the same as measuring feelings and thus does not measure any learning that took place (Kirkpatrick, 1996, p. 55). The measuring of reaction can be of importance because the affective reaction that a student has toward the subject matter and the way it is presented can have an effect on the outcome of said student’s results (Kirkpatrick, 1996, pp. 55-56). Students need to feel positive toward the work presented and like to learn (or be taught) in order to obtain the most benefit out of the learning process (Kirkpatrick, 1996, p.56). According to Kirkpatrick (1996), it is very important to measure participant’s reaction in a written manner using written comments (Kirkpatrick, 1996, pp. 56-57).

He justifies this statement by claiming that, if students do not like the module or the way it is taught, there is little chance that they will put in any effort to do well (Kirkpatrick, 1996, p. 56). Furthermore, Kirkpatrick (1996) states that it is important to obtain favourable reactions, because future learning interventions will depend on the reaction of current students (Kirkpatrick, 1996, pp. 56-57). However, this does not mean that positive affective reactions will translate into measurable learning that takes place (Hilton, 2006, p. 14). In many instances, measuring the success of a student is conducted by measuring the results of the student that took part in the game and evaluating the reaction toward the content presented (Hilton, 2006, pp. 15-16).

According to the second level of the model it is important to objectively determine the amount of learning that took place during the learning intervention (Kirkpatrick, 1996, p. 56). Kirkpatrick (1996), suggest that learning should be measured from each individual in order to quantifiably measure it (p. 56). This should be done in a pretest-posttest approach so that learning can be related back to the learning intervention, and as far as possible the measuring of learning should be done objectively (Kirkpatrick, 1996, p. 57). One of the key issues with GBL is the evaluation of the learning that took place during gameplay (Hilton, 2006, p. 15).

Kirkpatrick (1996) states that where possible the analysis of the pretest and posttest should be done statistically so that learning can be proven in terms of correlation or level of confidence (p. 57). However, when evaluating or measuring the learning that took place, there are key factors to take into consideration. Some of these factors include the educator's definitions of quantifiable learning, the objectives that is to be achieved, and how the learning is going to be measured (Ballance, 2013, p. 220).

Thirdly the behaviour of the students taking part in the learning experience is very important. There are some behavioural traits that has to exist among the students: they must want to learn (improve), they must know their weaknesses, they must learn in a permissive climate, they must have help from a skilled individual, and have the opportunity to learn new ideas (Kirkpatrick, 1996, p. 58). Behavioural changes are more difficult to measure than reaction of the students taking part in the learning intervention.

The fourth and last level of the model is called results. This is the objective of achievement for many studies and programs, may it be higher quality, better standards, or increased production. Kirkpatrick (1996), suggests that it is best to evaluate learning interventions in terms of desired results (p.59). He also gives a few guidelines to properly test the results of the learning intervention: use a control group, allow enough time for the results

to be achieved, measure both before and after training, and be satisfied with the evidence if absolute proof cannot be attained (Kirkpatrick, 1996, p. 57).

Paraskeva et al. (2010) claim that in games, knowledge or skills learned and practiced are more likely to transfer than when practiced on a single kind of problem (Paraskeva, Mysirlaki, & Papagianni, 2010, p. 499). This leads to the knowledge and skills becoming automatised and consolidated in memory, so that the learner can begin to focus on comprehending and applying new knowledge.

When arguing for GBL as an alternative to traditional teaching methods, such as the teacher/student classroom setup and online “off-the-shelf” games, the need and culture of the organisation should be taken into consideration (Ballance, 2013, p. 219). The student grouping that will use GBL needs to be taken into consideration, such as CIS students or more specific the undergraduate students or the post-graduate students. Scientists and educators repeatedly return to the conclusion that the advantage of GBL is that games tend to generate a much higher level of students’ positive emotional engagement, thus making the learning experience more motivating and appealing (Annetta, 2008, p. 233).

Kirkpatrick’s model can be used within any training or educational environment and has been proven to work. This study used these four levels of the model to create the research experiment (see par 3.3). In particular, the study was based on level 2 and level 4. These two levels aligned with the objectives (see par 1.4.2) of the study and what had to be measured. Using the guidelines set out in the model, the research experiment was conducted.

2.5. Traditional teaching methods

Traditional teaching can be described as a teacher-centred style of teaching where the orientation of the lecture is towards the teacher (educator) and the teaching style is inflexible (Boumova, 2008, p. 11). This style of teaching is concerned with the educator being the controller of the learning environment. All lessons are taught by the educator who plays the

role of instructor and decision maker in the form of choosing the curriculum and the teaching method used (Schwerdt & Wupperman, 2011, p. 367). The role of the educator is to introduce the students to the subject matter using an instructional board (white or black board) accompanied by a lecture or verbal explanation of the study material. After the lecture the educator will normally give students practical work to do in their free time or after class. Traditional teaching methods view the educator as the source of knowledge while the students serve as passive receivers. The educator regards the students as having “knowledge gaps” within a specific field or subject, and the role of the educator is to fill those gaps with knowledge on the subject (Boumova, 2008, p. 11). Generally, traditional teaching methods puts the responsibility of teaching mainly on the educator, and it is believed that if students are present in the lesson and listen to the educator as he/she explains the subject matter, they will be able to learn and apply what they have learned (Boumova, 2008, p. 11).

Traditional teaching methods that have been used for decades in all forms of education have some advantages and disadvantages that needs to be considered when determining which method of teaching should be applied.

Advantages of traditional teaching methods include F2F instruction which enable the students to ask questions directly to the educator and get an immediate response, a functionality that other styles of teaching do not have (Boumova, 2008, p. 11:12). Other advantages include receiving direct instruction from a well-versed educator in a subject, diversity in social interaction between classmates and educators, and access to specialised instruction from an educator (Boumova, 2008, p. 11:12; Schwerdt & Wupperman, 2011, p. 367:368).

Per Schwerdt and Wupperman (2011), traditional teaching methods are seen as old fashioned with many disadvantages: “lectures fail to provide educators with feedback about student learning and rest on the presumption that all students learn at the same pace” (p. 366). Another disadvantage is that students’ attention wanes quickly during lectures and then the

information tends to be forgotten when the students are passive. Moreover, traditional teaching methods also emphasise learning by listening which may be a disadvantage to students who prefer to learn through other styles of teaching (Schwerdt & Wupperman, 2011, p. 366). Consequently, better student engagement with better interactive lessons need to be considered for use in the teaching methods of educators (Porter, 2006, p. 521).

2.6. Games in education

2.6.1. Definitions and motivation

A game, as defined by Garris et al. (2002), is an activity that is voluntary and enjoyable, separate from the real world, uncertain, unproductive in that the activity itself does not produce any goods of external value, and governed by rules (Garris, Ahlers, & Driskell, 2002, p. 442). Zimmerman (as cited in McClarty, et al., 2012) defines a game as “a system in which players engage in artificial conflict, defined by rules, that result in a quantifiable outcome” (p. 5). Participating in a game in the pure sense of the word does not intend to represent any real-world system: it is already a “real” system. Games are governed by rules and strategies, and generally represent activities that are separate from reality in that there is no activity outside the game that literally corresponds (Annetta, 2008, p. 230 & Garris, et al., 2002, p. 443).

The term “video game” builds on this definition, and is defined by the Oxford dictionary as “a game played by electronically manipulating images produced by a computer program on a monitor or other display” (Oxford University Press, 2014). Gee (2003), describes the term “video game” as both games played on video game platforms (such as consoles like the Xbox, and PlayStation), as well as games played on a computer (Gee, 2003, pp. 1-2). The term “video game” serves as the reference for both console based games as well as computer-based games. In line with these definitions of the term video game, this study focuses on computer based games, as this is the platform that CIS students use at the MA. For the study the term video game will be used to refer to games played on a computer platform.

Modern video games refer to the latest generation of computer games designed for training or education purposes (Kebritchi, 2010, p. 256). They have significantly improved over the last decade and moved on to three-dimensional graphics and interfaces, multiplayer options and high-speed telecommunication techniques.

The video game industry is a very lucrative multibillion-dollar industry (McClarty, et al., 2012 p. 6; Buckley & Anderson, 2006, pp. 363-364). The global market is worth billions, and development costs, revenue, and players of video games often exceed that of the movie industry (McClarty, et al., 2012, p. 7). Gaming is no longer just a niche for a small number of avid gamers. Games have become the most popular software on the planet and have an incredible following of all ages (Jayakanthan, 2002, p. 98).

Within the informal setting of leisure time and play, computer games have become one of the most time-consuming hobbies of many people (Burgess, Stermer, & Burgess, 2012, p. 378). Games are discussed in detail, read about, fantasised about, cheated at, modified and played online daily (Gee, 2003, p. 2). Within Modern society, games and gaming have become an intricate part of our social behaviour. Thus, it does not come as a surprise that many have conducted research in the field of using computer games as educational tools (Annetta, 2008; Borokhovski, et al., 2016; Chmiel, 2015; Festl, Scharrow, & Quandt, 2013).

Video game designers have become very good at teaching and learning because, if players find the game too complicated they will not play it (Gee, 2015, p. 21). Within the video game world there are many different genres of games, these consist of the action shooter games, adventure games, roleplaying games, simulation and strategy games (Gee, 2009, p. 70). All these genres are designed to get the players attention and keep their attention, and this is one factor that makes video games good educators (Gee, 2003, p. 102).

While commercial video games have genres to keep the player's attention, educational games exist in many different forms, including the use of entertainment games for education,

the design of immersive learning environments and the use of virtual worlds for learning (Dickey, 2011, pp. 457-459). Educational games commonly require the use of logic, memory, problem solving, critical thinking skills, visualisation, and discovery (Annetta, 2008, p. 231).

Video game playing is a highly pervasive activity, providing a multitude of complex cognitive and motor demands (Kuhn, Gleich, Lorenz, & Gallinat, 2014, p. 265). The gaming medium provides that extra interactive edge, an insight not lost on commercial or social bodies that are using gaming as part of their youth communication programs, to help improve message cut through and longevity (Hilton, 2006, p. 14).

Within the literature, it is suggested that video games encourage learning and co-operation (Annetta, 2008, p. 232 & Gee, 2003, p. 155). Games are some of the most interesting ways students can learn new things (Jayakanthan, 2002, p. 98). Games provide players with “good learning”; this is learning guided and organised by principles empirically confirmed by systematic research on effective and deep learning (Gee, 2009, p. 70). Games can be used for different types of learning including: skill and drill, creation of deeper conceptual understandings, and problem solving abilities that go beyond being able to pass paper-and-pencil tests (Gee, 2009, p.72).

Gumulak and Webber (2011), mentions that educational researchers and librarians are considering using games to improve literacy amongst students (p. 243). Games do not necessarily teach literacy or language proficiency explicitly, but many have short lines of text that forces the player to read with comprehension and understanding of what has to be done (p. 243).

Furthermore, educational computer (video) games are considered effective as teaching tools because they use action instead of explanation, create personal motivation and satisfaction, accommodate multiple learning styles and skills, reinforce mastery skills, and provide interactive decision-making contexts (Kebritchi, 2010, p. 263).

Burgess, et al. (2012) state, “one of the oversights within video game research is the paucity of studies examining college age students and academic variables” (p. 378). Many students at college or the age of their college-attending counterparts grew up playing video games; this was not the norm two decades or so ago. Thus, the relation between video game play and school performance may have changed as video games have become more popular amongst youth (Burgess, et al., 2012, pp. 378-379).

While we may question motivations and ethics, it has clearly been established that video games have become acceptable in education, and seen as educationally worthwhile because games require intelligent performance (Hilton, 2006 & Howarth, 1999). The study will not strive to test or debate whether games should be used in education. It will test to what extent gaming (GBL) can help students to learn CIS subject matter at the MA.

2.6.2. Advantages and Disadvantages of games in education

Although there are some strong advocates for the use of games within education, (Gee, 2009, pp. 67-71 & Gee, 2003) there is some controversy that exist about the value that games present to education. Some authors have conducted extensive research within the field of gaming for education and while there is still concern about the possible adverse effects of game playing, such as poorer performance in academic studies (Burgess, et al., 2012, p. 376), many researchers focus on the positive educational and developmental aspects of video game playing (Gee, 2009, p. 68).

McFarlane et al. (2002), (in a study conducted with students, parents as well as educators) found that games were perceived as supporting personal development, language and literacy, mathematical skills, student creativity, understanding of the world and physical development (McFarlane, et al., 2002, p. 13). Within the McFarlane et al. study, most educators noted that video games were supportive in developing communication and collaboration skills amongst students.

Vos and Brennan (2010) suggest that educational games give valid representations of real world issues facing learners including enhanced skills in strategy formulation, analysis of multiple variables, integration of a range of concepts and tools, problem solving, communications and team work (Vos & Brennan, 2010, p. 883).

Video games also teach perceptual skills and problem solving skills. People who play video games show better attention to cues across the visual field and attend to more visual cues overall than people who do not play video games (Buckley & Anderson, 2006, p. 365). Nauert (2013) found that playing video games improved the player's capacity to think about objects in three dimensions, just as well as academic courses to enhance these same skills (Nauert, 2013).

Video games force gamers to think on their feet, and action-games such as first person shooter games encourage players to better use evidence drawn from their senses in decision-making as well as provide many problem-solving contexts that require the use of logic, memory, problem-solving, critical thinking skills, visualisation and discovery (Hong, Lui, 2003, McDaniel, 2010 & Annetta, 2008, pp. 230-232). Players must analyse, employ their cognitive skills, and use trial and error to solve problems, which arise within the game (Gee J. P., 2011, p. 231).

Gee (2003), notes that playing video games can develop problem solving skills that can be directly used outside of the gaming context (Gee, 2003, pp. 44, 109). Gee (2003), also argues that gaming accommodates different learning styles that can accommodate all kinds of students (Gee, 2003, p. 195). Furthermore, video game playing and computer use have been associated with higher levels of spatial skills, but overall poorer school performance (Burgess, et al., 2012, p. 378). Nauert (2013), points out that the effects of gaming on the player can be very positive, the interaction between the player and the game can boost the players learning, health, and

social skills (Nauert, 2013, p. 1). Playing video games can be beneficial to a student and increase their range of skills such as reasoning, memory and perception.

Therefore, for those educators whose teaching philosophy focuses on the learning process, games can be used to develop skills such as problem solving, decision-making under pressure, and evaluation and analysis within a practical setting (Howarth, 1999, p. 29).

Although a large part of the literature focusses on the positive and beneficial effects of playing games, some authors still have some concerns about the adverse effects games may have on students. There is relatively little research that examines the relationship between video game use and other behaviours like school performance (Burgess, et al., 2012, pp. 377-378).

However, many authors have expressed concern that video games promote violent behaviour, and is associated with smoking, obesity, and poor academic performance (Buckley & Anderson, 2006; Burgess, et al., 2012). Burgess, et al. (2012) further notes that the amount of time spent playing video games can have a detrimental effect on school performance (Burgess, et al., 2012, p. 377). Furthermore, the content of games can be troublesome for some as there is a negative relationship between exposure to violent media and academic performance (Buckley & Anderson, 2006, p. 366).

Within the literature, one negative effect is a prevalent theory within many studies; aggressive behaviour and the outcomes thereof (Buckley & Anderson, 2006; Burgess, et al., 2012; Gumulak & Webber, 2011). Buckley et al. (2011) state that just as educational games can be used to teach educational content, violent video games can teach aggression (pp. 364-366).

Notwithstanding the drawbacks, it is apparent the games can be used to teach students. In line with this notion, the study focuses on games in education and tests games in education in a GBL environment. The results of the study will give a definite answer on if GBL can be

used effectively at the MA in a CIS module. Although there is evidence that too much gameplay can have detrimental effects, GBL is merely suggested as a supporting teaching pedagogy to traditional teaching pedagogies.

2.6.3. Teaching with games

Internationally, it is well understood that games promote cognitive reasoning and information retention (Ballance, 2013, pp. 218-219). Educational games are considered powerful tools because they have potential for improving the quality of the educational system, yet school or educational institutions do not readily adopt games (Kebritchi, 2010, p. 257).

Problems in the real world vary in content and structure. This is also true in games where problems arise that are both simple and complex. A technical problem may have one unvarying solution, whereas a tactical problem may require detailed analysis of an opponent's strengths and weaknesses (Howarth, 1999, p. 31).

When it comes to decision-making Howarth (1999) states decisions that are made during more complex problem solving require us to weigh the facts and consider the alternatives (pp. 29-30). In games, decisions often must be made very quickly under pressure and in changing situations. Howarth (1999) goes further to say that games teach the player analytical skills and the set of criteria to which we determine standards of evaluation of a situation (p. 30).

Many games that are developed for non-academic purposes can have educational content. Video games motivate learning by challenging and providing curiosity, beauty, fantasy, fun, and social recognition. Video games also have a positive effect in the development of cognitive functions in adolescents and children (Granic, Lobel, & Engels, 2014).

Games can reach learners who do not do well in conventional settings such as teacher/student classroom settings (Annetta, 2008, p. 230). Furthermore, Vos and Brennan (2010) note that educators have long accepted that they cannot rely solely on didactic methods; the nature of modern education necessitates that in addition to addressing a body of knowledge

through lectures and reading, students must engage in active learning (pp. 883-884). Active learning can include the use of games in education to facilitate learning through gameplay.

In corporations, learning through gameplay is growing in popularity and provides benefits to the learner (Ballance, 2013, p. 218). Typically, educational games also include instructional components such as learning objective and/or outcomes.

Organisations are considering games, because games are the perfect way to tap into the power of a visually related story to engage an audience and to aid in important acts of recall. Games put active participation at the heart of the learning experience, making the learner more likely to retain and remember what they have learned through interactive engagement during the learning experience (Ballance, 2013, p. 219).

The fact is, gaming is what many young employees do in their spare time, on both computer and mobile devices (Ballance, 2013, p. 219). Good educational games can draw us into virtual environments or circumstances that look and feel familiar and relevant, which is motivational because we can quickly see and understand the connection between the learning experience and our real-life environment (Ballance, 2013, p. 220).

Moreover, educational games seem to be effective in enhancing motivation and increasing student interest in subject matter, yet the extent to which this translates into more effective learning is less clear (Annetta, 2008, p. 231). In fact, video games have many factors that make them excellent educators: they successfully get a students' attention, they teach attitudes necessary for successful behaviours, they enable people to feel competent about performing a task, and they allow people to actively participate, instead of passively watch and listen (Buckley & Anderson, 2006, pp. 365-366).

The success of games in engaging students lies in the mechanics of how they are designed. These include a rewards system, options that allow the user to navigate obstacles in a personalized way, opportunities to try out hypothesis and to fail in a safe space, and

interactive challenges that unfold logically (Krotoski, 2010, p. 695). Reward systems in games work on the same principles as operant conditioning. If the player makes the wrong choices in the game the player will immediately know; this will either happen because of character death or not reaching the goals set within the current game chapter or stage. The positive effect of the reward systems built into games will be advancing to a new chapter or receiving special equipment and consumables for the character the player is portraying.

The idea of “play to learn” is a new concept (Annetta, 2008, p. 231). Therefore, many educators have set their focus on the positive educational and developmental aspects of video game playing (Gumulak & Webber, 2011, p. 242). Some authors (Gumulak & Webber, 2011, p. 242; Annetta, 2008, p. 231; McFarlane, et al., 2002, p. 13) argue that games fit with problem-based and creative approach to learning, appropriate for preparing children to deal with twenty-first century life. McFarlane et al. (2002) found that games were perceived as supporting personal development, language and literacy, mathematics skills, creativity, understanding of the world and physical development (McFarlane, Sparrowhawk, & Heals, 2002, p. 31). Play systematically confronts the student with a learning situation that could only be located within his or her area of close development, meaning it would involve a task slightly above the acquired skills (Annetta, 2008, p. 232).

Krotoski (2010) notes that, over the past decade, evidence has grown that computer-based play can support learning in schools. Students whose lessons included interactive games were more engaged in curriculum content and demonstrated deeper understanding of concepts than those who did not use games (p. 695).

Both educational games and “pure entertainment” games can be used to teach. This is because gamers are persistent in the quest to complete challenging games (Gee, 2003, p. 6). For a player to complete a game, they must adapt to the game environment and learn skills to overcome the game and win. This implies that educational games are not explicitly the only

educational games and “pure entertainment” games are at their core educational (Gumulak & Webber, 2011, p. 363). Gumulak et al. (2011), notes that different educators use commercial games to identify challenges in the classroom and the real world, such as keeping the learners focused on the work and taking in what is taught (p. 369).

Games demand a level of literacy that players do not always possess, but by triggering interest the player will do all that is necessary to understand what is expected within the game (Gumulak & Webber, 2011, p. 370). McFarlane et al. (2002) state that parents as well as educators feel that games can be used to teach literacy, because they force the player to read with comprehension (McFarlane, et al., 2002, p. 14). Moreover, gamers can publish their opinions or solutions online, improving their information literacy through interaction with other players (Gumulak & Webber, 2011, p. 365).

Per Buckley et al. (2006), schools have effectively taught algebra and geometry, biology, photography, golfing skills, and computer programming successfully (Buckley & Anderson, 2006, p. 365). Students with learning disabilities have been taught life skills successfully through virtual reality gaming (Standen & Cromby as cited in Buckley & Anderson, 2006, p. 365).

Furthermore, Buckley et al. (2006) indicated that video games have been successfully implemented to teach diabetic children how to take care of their disease. Participants showed as much joy playing the educational game as children who played commercial games, playing it repeatedly (Buckley & Anderson, 2006, p. 365). Video games also teach even when they are not intended for pure education.

Moreover, many factors exist that make video games excellent educators. Video games successfully get people’s attention; they teach attitudes necessary for successful completion of challenging chapters within games. They enable people to feel confident in performing a task, they are motivating, they allow people to actively participate, instead of passively watch and

they show the entire step necessary to perform a task or series of tasks (Buckley & Anderson, 2006, p. 367).

Video games are motivating because they allow players to control the game and players can repeat the material as needed, they also give immediate feedback, and they have a built in reward system (Buckley & Anderson, 2006, p. 367). Video games force the player to think on their feet and encourage better evidence gathering from their senses. Gamers show better attention to cues across the visual field and attend to more visual cues overall than non-gamers, which enables them to make sound snap decisions (Buckley & Anderson, 2006, p. 368).

With all this taken into consideration, video games, or just playing a game, may be feasible to use within an educational setup to teach students successfully. Video games are used within education around the world and within academic environments. This suggests that games can be used within the MA to teach students at a tertiary level and within specific subjects such as maths, biology, and computer information systems (Buckley & Anderson, 2006, p. 365).

2.7. Game-based Learning (GBL) in education

Tertiary academic modules today do not benefit from commercial “off-the-shelf” training, or more time in the classroom (Ballance, 2013, p. 218). They need effective, interactive experiences that engage us in the learning process. That is where GBL comes in (Ballance, 2013, p. 219).

A reasonable amount of research has gone into using games as teaching tools and one of the concepts is called GBL (Dickey, 2011, p. 457). GBL describes an environment where game content and game play enhance knowledge and skills acquisition, and where game activities involve problem solving spaces and challenges that provide players/learners with a sense of achievement (Qian & Clark, 2016, p. 51). GBL includes training games, simulation games, or skills building games that can be used in education, workforce training, healthcare, the military

and public policy (Tappeiner & Lyons, 2008, p. 123). Moreover, GBL includes games designed to educate, train, incite activism, inform, persuade, express, recruit or indoctrinate a student (Dickey, 2011, p. 458). Generally, GBL is designed to balance subject matter with gameplay and the ability of the player to retain and apply the knowledge gained from the learning to the real world (Qian & Clark, 2016, p. 51).

Per Gee (2009), GBL describes an approach to teaching where students can explore relevant game aspects in learning context designed by educators (p. 76). GBL focus on games that involve learning different kind of domains, skills or content that we associate with school, work, health, knowledge construction, or community building, and not limited to the pure popular form of entertainment (Gee, 2009, p. 68). GBL platforms are games commonly known as serious games and educational games. GBL is a common term with broad interpretations and can include educational games, edutainment, or entertainment games (Qian & Clark, 2016, p. 52).

For this study, GBL will be the term used to encompass educational games, edutainment games, and serious games being that these terms are all generally used to describe games meant for teaching and learning purposes.

GBL can be used to teach students literacy. By using GBL to teach students it stimulates discussions of important social, intellectual and academic subjects making GBL a good teaching tool (Gee & Williamson Schaffer, 2010, p. 5). In the 21st century students and learners need skills like innovation, critical thinking, and systematical thinking which are all seen as good principles of learning. In other words, the students of today need to learn the concepts and principles that video games are so good at teaching (Gee & Williamson Schaffer, 2010, p. 7)

GBL has changed the way that educators view teaching to meet the needs of the current generation of students (Annetta, 2008, p. 230). By using GBL, we work toward a goal, act,

experience consequences of our actions and make mistakes in a risk-free environment, which enables trainees and students to learn new skills and knowledge by playing and making mistakes without dire consequences (Ballance, 2013, p. 218).

GBL has long been the interest of many educators, and many different games have been tested and used within the last decade (Chmiel, 2015). Researchers have been interested in the potential of commercial games for learning; more so researchers are interested in the use of GBL for education (Gee, 2011, p. 1). Gee (2011) also adds that the evidence for and against GBL is not extensive. It is relatively new and the evidence gathered is a mixed bag (Gee, 2012, p. 1). Before relevant evidence can be provided in regard of GBL, a good deal of work has still to be done (Gee, 2011, p. 2).

2.7.1. Benefits of GBL

Within the literature many authors made statements such as GBL “improved analytical skills”, “improved problem solving”, “helped learn concepts”, “applied what was learned in class”, and “taught fundamentals” (Alexander, Brunye, Sidman, & Weil, 2005; Annetta, 2008, pp. 230-233; Hilton, 2006, pp. 14-16; Howarth, 1999,).

McFarlane, et al., (2002) distinguished between three potential benefits of the use of GBL within an educational environment: general cognitive abilities and skills, affective motivational aspects, and knowledge and content related learning (McFarlane, et al., 2002, p. 7). Ricci, et al., (2002) notes that their study showed that GBL can enhance knowledge training and retention, however the specific attributes of gaming, aside from motivational appeal, require further investigation (Ricci, Salas, & Cannon-Bowers, 2002, p. 297).

Within the literature, the strongest support for GBL is the claim that GBL improves the affective and motivational aspects within formal schooling (Annetta, 2008, Burgess, et al. 2012; Buckley & Anderson, 2006; Gee, 2003, p. 192; Hilton, 2006). Chmiel (2015), points out

that learning theories from the sociocultural cognition family of learning implies that GBL have the potential to motivate, engage, and provide authentic learning experiences.

Per Ricci et al., (2002) three attributes are directly related to the motivational appeal of GBL: dynamic interaction, competition and novelty. These attributes can produce significant differences in students' attitude and the impact on learning can be attributed to increased attention in the learning environment (p. 299).

Qian and Clark, (2016) stated that many authors pointed out that GBL might be superior to traditional classroom instruction as it could increase students' motivation for learning and provide them with opportunities to explore and acquire new knowledge and skills (Qian & Clark, 2016, p. 50). Furthermore, Vos and Brennan (2010) stated that students find GBL to be both stimulating and enjoyable experiences and that this enhances their learning (p. 884). Despite this potential for better motivation, enjoyment, and engagement of students, GBL has struggled to penetrate the formal educational environment (Chmiel, 2015).

Although GBL has not been widely used, interest in GBL among scholars, organisations, educational technology start-ups, large educational companies, and even the White House of the USA has increased since the beginning of the twenty-first century (Chmiel, 2015). GBL studies reveal varying degree of success dependent upon academic topic, learners' preferences and age, and GBL positively influence attitudes and cognitive gains (Qian & Clark, 2016, p. 51).

Furthermore, Chmiel (2015) notes that within the field of GBL leading theorists are exploring the intersection of games and learning, and what games can teach us about learning (Chmiel, 2015). Chmiel (2015), then goes further to state that GBL is typically discussed in the context of designed learning experiences both in terms of what learning designers can gather from game design and how to utilise GBL as part of a designed learning experience (Chmiel, 2015).

Many successful entertainment games provide incredibly realistic and immersive environments where gamers can learn through role-play experiences. These games can provide a successful design model within the educational environment for GBL (Qian & Clark, 2016, p. 52). Gee (2009), state that GBL holds out great potential for human development. There is no reason to look at GBL simple as “fun”, just as there is no reason to think of learning as “serious” (Gee, 2009, p.68).

GBL games require strategising, hypothesis testing, or problem solving usually with higher order thinking rather than rote memorisation or simpler comprehension (Paraskeva, Mysirlaki, & Papagianni, 2010, p. 498). Moreover, GBL environments allow for development of higher levels of learning and collaboration skills, as well as improved reasoning skills (Annetta, 2008, p. 233). Krotoski (2010) noted that in 2006 the examination results given by the UK educational department and software publisher, the scores and educator ratings were higher when both commercial and educational games were used as support materials (Krotoski, 2010, p. 695).

Good GBL games teach and set up good learning opportunities in ways that are well supported by research in the Learning Sciences (Gee, 2015, p. 21). Gee, (2015), also pointed out that to see why games are hailed as a new educational technology it is very important to look at what a video game is. At its heart, a video game is a set of problems to solve and by doing so learning takes place whether it is by learning how to build a house in *The Sims*, or by solving an algebra problem in *Dragon Box* (Gee, 2015, p. 21).

Gee, (2015), then goes further to state that within teaching and learning the design skills and their concomitant teaching and learning principles can be used by all curricular activities and not just for GBL.

2.8. Games and the Military

Shrinking military budgets demand that training resources be allocated in a manner that optimises skill acquisition and retention (Ricci, et al., 2002, p. 295) The Military's traditional way of training is strained by logistical challenges, and limited resources; this puts strain on the training of officers and students, as well as educators and facilitators at military institutions (Alexander, et al., 2005, p. 1).

Students within the military often need time to practice the complex skills they study and practice them to proficiency. This can be a very costly exercise if conducted by the traditional way of military training. "Initial learning in any environment entails the acquisition of basic knowledge elements" (Ricci, et al., 2002, p. 296), and trainees or students must grasp basic facts and concepts before they can compile and transform this knowledge into subsequent procedures (Ricci et al, 2002). This could be done by using a GBL game at a fraction of the cost of traditional training (Alexander et al, 2005, p. 1). Military educational institutes have always utilised games to think clearly about military operations (Meijer & Smeds, 2014, p. 1).

The MA has also been using Microsoft Flight Simulator within the Aeronautical Science undergraduate modules to teach Pupil Pilots the basics of flying a plane as well as the workings and aerodynamics of fixed wing aeroplanes used by SAAF. Simulators are systems that emulate visual stimuli and physical controls from the operational environment (Alexander et al, 2005, p. 1).

Traditionally, two approaches are followed when providing training within the military; traditional teaching methods being the first, and simulators (also seen as games by some) the second. The military uses traditional teaching methods to educate and train their soldiers and students. Traditional teaching methods are educator-centered and involve attending lectures, the oral presentation of the subject matter by a subject expert (educator), and provide valuable declarative knowledge to students (Alexander et al, 2005, p. 1). Traditional teaching requires

students to show their knowledge and skill within modules by performing practical skills such as programming, or setting up project plans and by completing evaluations successfully (Ricci et al, 2002, pp. 296-297).

Furthermore, traditional teaching methods at the MA are supplemented using SUNLearn (Stellenbosch University's e-learning platform powered by Moodle) as part of the e-learning requirements of the University of Stellenbosch (Stellenbosch University, 2013). E-learning is a more engaging way of teaching and helps to facilitate the learning of students using technologies that can facilitate the learning experience, normally through a learning management system such as SUNLearn.

Secondly, the military utilises games to facilitate teaching. From the invention of video games, they have always been a substantial part of what is the "military-entertainment complex" which is deeply imbued with militaristic messages and imagery (Festl, Scharkow, & Quandt, 2013, p. 392). Meijer, et al (2014) notes; "in the military, games have been used for centuries to think clearly about military operations" (Meijer & Smeds, 2014, p. 1).

In educational war-gaming, officers are challenged with real-world problems by facing an adversary in the game (Meijer & Smeds, 2014). War games are not used to enhance user motivation or engagement, although they may afford participants a great deal of satisfaction (Meijer & Smeds, 2014, p. 2). The purpose is to stimulate officers into tactical thinking and decision-making that corresponds to real-world situations without paying the real-world penalties (Meijer & Smeds, 2014, p. 3). For this reason, (and many others) it is no surprise that the military has embraced the use of GBL environments such as simulations and games to teach soldiers skills they need to solve real world problems, train them for combat, flying, driving tanks, and commanding troops (Buckley & Anderson, 2006, p. 364).

Prensky (2001), states that the military uses games to train soldiers, sailors, pilots and tank drivers to master their expensive and sensitive equipment, and it uses games to train

command teams to communicate effectively in battle (Prensky, 2001, p. 2). Furthermore, the military uses games to teach mid-level officers how to employ joint force military doctrine in battle and other situations, and teach senior officers the art of strategy (Prensky, 2001, pp. 2-3). Within the SANDF soldiers are trained using games within the following areas: School of Armour have simulations that is used for the training of Rooikat crewmembers as well as Olifant MBT (Main Battle Tank) crewmembers. Air Force Base Langebaanweg also have simulators that teach pupil pilots the working of the Pilatus PC7 Mk 2 training aircraft used within the SAAF (South African Air Force). The Infantry Corps of the SANDF have numerous simulators that are used for training including mortar specialist training, machine gun specialist training, practical shooting training, and many more. The SANDF also implements the use of the military doctrine and strategy based game, Arma, in teaching military personnel to better understand the fighting doctrine and how to engage the enemy correctly.

The fact that such a vast part of the SANDF have been using GBL learning environments for more than a decade within training and continue to do so shows that GBL could hold great benefits for students at the MA.

2.9. Summary

Various learning concepts and teaching pedagogies have been identified and reviewed within this chapter. Games and GBL within higher educational environments have been discussed within this chapter. Theoretically reviewing the literature shows that GBL can be a feasible teaching pedagogy within the SANDF at the MA and can have positive effects on student performance. Furthermore, educators must stay up to date with teaching technologies and adapt to the new generation of adult learners at the MA. This will ensure a well-balanced class concerning engagement and getting through to students. However, the digital divide, and under-privileged students must be kept in consideration. The literature review was dedicated to theoretically investigate if GBL can be used at the MA.

CHAPTER 3

RESEARCH METHODS

3.1. Introduction

The Literature review in Chapter 2 is the theoretical foundation and framework for the methodology is set out in this chapter. A discussion and explanation of the research methodology, research design, participants of the study, the game used for the GBL grouping, materials used within the study, the experimental procedure followed and statistical data analysis will be provided.

The introduction on the discussion of the research methodology followed, necessitates an understanding of why research is conducted (Grundlingh, 2013, p. 87). Rosnow and Rosenthal (cited in Grundlingh, 2013) explain that “research is a scientific method used to make sense of the world and to provide answers to formulated questions.” (Grundlingh, 2013, p. 87). This study focuses on quantitative research that involves measuring variables and obtaining learning gain scores. The research plan set out describes the intention of the study and what steps were followed to answer the research questions and test the research null hypothesis (Mouton, 2005, p. 66).

Per Grundlingh (2013), the research design can be classified as either empirical or non-empirical (Grundlingh, 2013, p. 87). Furthermore, research can be qualitative or quantitative or a combination of both. Quantitative research is used when the relationship between variables is measured. Quantitative research focuses on the analysis of more variables and enables the use of statistical analysis to determine the significance of results. Within quantitative research a theory is put forward and a way of testing the theory is planned, this enables the theory to be tested and measured quantitatively and confirm or disconfirm the theory (Creswell, 2014, p. 119).

The research design of this study is empirical in nature and follows a quantitative approach. The emphasis is placed on the quantification of the data gathered during the research experiment. The study was conducted as an experimental study and adopted a pretest, intervention, posttest design.

In this study, much like other quantitative studies, the participant's answers to items in a questionnaire are categorised, and manipulated for statistical analysis. The study adopted an experimental design to investigate if GBL can be effectively used as an educational tool. The lack of existing studies within the MA and the SANDF (investigating whether GBL can be a feasible way of teaching) serves as another venturing point for using the experimental methodology.

3.2. Research phases

The study was conducted in five phases (see figure 2).

The first phase of the study focused on learning and learning theories, games and gaming in general, GBL within a tertiary educational institute, and games within the military environment especially within the MA. Within this part of the study, literature was used to understand the concept of learning and how we learn through exploring different theories of learning and practical applications of learning theory. Furthermore, the first phase set out to identify what factors contribute to the learning of a student and the possible theoretical results GBL can have on a student's learning experience and academic results.

The second phase of the study, as depicted in Table 2, comprised of the research experiment. Within this phase of the study the experiment was set up, teaching materials were printed, venues were finalised and the pretest was written before any intervention took place with the participants.

Table 2

Research Experiment Groups

Phase 2		
Group 1 - Control	Group 2 - GBL	Group 3 - Traditional teaching
No learning intervention took place	Played Code Combat to learn JavaScript	Were taught JavaScript via lectures
	No traditional teaching took place	Traditional classroom setup

As can be seen in Table 2 above, within the second phase of the study the control group (group 1) had no intervention in any way. The participants in the GBL group (group 2) played Code Combat (see par 3.3) that taught them JavaScript through gameplay. The traditional teaching group (group 3) were taught within a traditional lecturer-student classroom setup where the lecturer taught them JavaScript. After the intervention was concluded all participants from all three groupings were required to write the posttest in order to calculate the learning gain scores of all the participants.

A sample of undergraduate CIS students of the MA were used for the study. Participants all had to be residential students of the MA and had to be enrolled for any undergraduate CIS module. The experiment was conducted to test if the learning gains from GBL are higher than that of traditional teaching methods as followed by tertiary educational institutes as well as the MA. This was conducted to motivate GBL as a valid teaching method within the MA at a higher educational level.

The third and fourth phases comprised assessing the results of the pretest and posttest, conducting statistical analysis in the form of calculating learning gain scores, descriptive

statistics, as well as single factor ANOVA to draw significant results from the data, and testing the research hypothesis in order to accept or reject them.

During phase five of the study (see Chapter 5), the results were set out and conclusions were drawn from the calculated results. The results were discussed and limitations to the study was drawn as well as recommendations for future research. Figure 2 outlines the five different phases of this study.

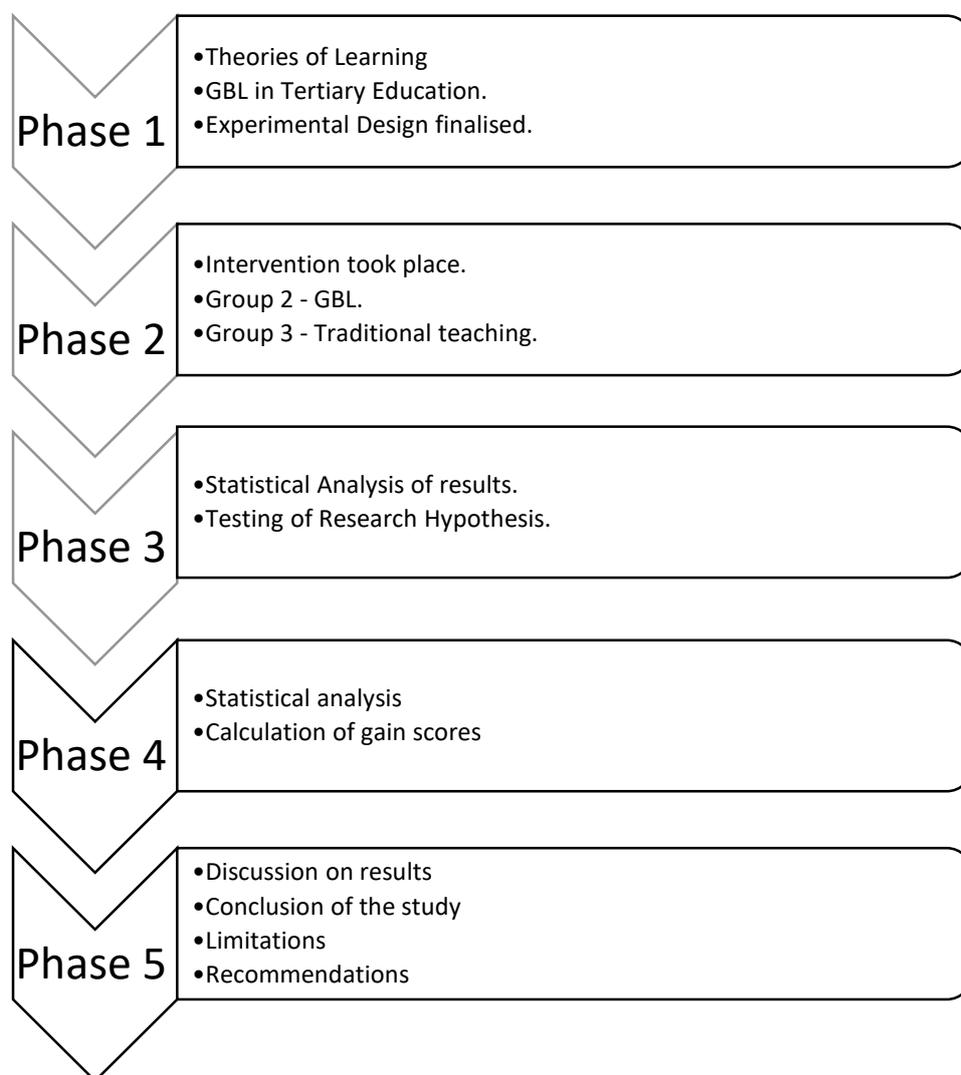


Figure 2. Different Phases of the Study.

3.3. Research design

An experimental research design based on Kirkpatrick's four levels of training (see par 2.4.5) was used to explore the relationship between GBL and traditional teaching methods. The experimental method is a systematic scientific approach to research in which the researcher manipulates one or more variables, and controls and measures any change in other variables. The study was conducted by doing a true experiment where participants were randomly assigned to a group and only one effect was tested at a time. In the case of the research experiment, the effect tested was the impact of GBL on the learning gain of a MA student.

The study aimed at indicating significant differences between GBL and traditional teaching methods. The study aimed to determine how the dependent variable relate to the independent variables. The independent variable is the factor that the researcher observes and measures to determine how it is affected by the independent variable (Reynolds & Fletcher-Janzen, 2007, p. 1723). The dependent variable for this study is learning gain scores. Per Reynolds et al, the independent variable is the factor the researcher selects to determine the effect it has on the dependent variable (Reynolds & Fletcher-Janzen, 2007, p. 1723). The independent variables for this study is the different teaching methods namely GBL, and traditional teaching methods.

Participants were tested in a pretest-posttest designed experiment to test the research hypothesis. The participants all had similar tertiary academic and military backgrounds. Additional information gathered from the participants was to identify their age, area of study, and Arms of Service within the SANDF.

Both the pretest and posttest were in the form of a questionnaire that had questions related to JavaScript and had no questions of any sensitive or personal manner (i.e. ethnicity, gender).

3.4. Measuring instruments

The research set of questionnaires consisted of two sections. The first section focused on biographical information where participants were asked to provide information with regards to their age, gender, Arms of Service, and prior programming experience. The section did not include questions like racial group, marital status, or highest educational qualification. The next section consisted of questions on JavaScript and was ultimately used to calculate the learning gain scores.

The second section of the questionnaires was in the form of a test that included multiple choice questions, short answer questions where participants had to write JavaScript code, and questions where they had to fix JavaScript code. The multiple-choice questions included questions on the basic syntax of JavaScript, variable declaration questions, loops and logic questions. The short answer questions comprised syntax errors in code that had to be corrected, logic errors that had to be corrected and loops that had to be correctly assigned.

The questionnaires went through moderation and approval by the CIS lecturers, the departmental chairperson and the Stellenbosch University Ethics committee. Only after the above-mentioned parties all agreed the questionnaires could be used, and after written consent by the participants themselves, were the questionnaires used for the research experiment.

3.5. Sampling design

Babbie, Mouton and Field (cited in Grundlingh, 2013) state that the population is the group being studied and is the group from which conclusions will be drawn (Grundlingh, 2013, p. 87). Grundlingh (2013), describes the population as a collection of the research subjects who share characteristics that are of interest to the researcher (Grundlingh, 2013, p. 90). The population of this research study are residential undergraduate CIS students of the MA within the SANDF, and have gone through roughly the same military training before enrolling at the MA for tertiary education.

Within the SANDF there are four Arms of Service namely, SA Army (SAA), SA Navy (SAN), SA Air Force (SAAF), SA Medical Health Services (SAMHS) and the student population at the MA consist of all four Arms of Service. The MA is a tertiary educational unit within the SANDF and offers a tertiary education to officers from the different Arms of Service within the SANDF (Grundlingh, 2013). The MA forms part of Stellenbosch University and is situated in Saldanha in the Western Cape.

At the MA the students are mostly junior officers with the rank of Candidate Officer, Second-Lieutenant, Lieutenant, and Captain for SAA and SAAF, and with the rank of Midshipmen, Ensign, Sub-Lieutenant, and Lieutenant for SAN. Thus only junior officers were used for the study. Participants that volunteered for the study were all residential undergraduate CIS students. Within the study there were students from SAA, SAN and SAAF. The data used within the study was collected from these participants. The participants serve as a subset of the MA undergraduate student population and was used to infer things about the whole student population.

Before data gathering took place, the study was approved by the MA, following normal ethical approval procedures at the University of Stellenbosch Ethics Committee, and informed consent from the participants themselves. No information with regards to ethnicity or gender was required of the participants, just the participant's age and area of study as well as Arms of Service. All participants took part in the study voluntarily and could exit the study at any given time. Freedom of participation required participants to complete a consent form obtained from Stellenbosch University that explicitly stated that they could withdraw anytime they no longer wanted to participate in the study.

The study was conducted within the military (SANDF), and thus permission to conduct the study was obtained from all authorities necessary in the SANDF. After the relevant authorities granted permission for the study to commence, participants were approached to

explain the purpose of the research and how it would be conducted. Participants were also ensured about the confidentiality and anonymity of the study. The results of the study were kept confidential, strictly adhering to the ethical standards of research. All ethical requirements stipulated by the Stellenbosch University Ethics Committee were strictly adhered to.

Participants were randomly allocated to one of three groupings. The first grouping was the control group that received no form of intervention but still wrote both the pretest and the posttest. The group started out with 20 participants that completed the pretest ($n=20$), however 8 students exited the study before writing the posttest, leaving only 12 participants to complete the research experiment ($n=12$). The results from this grouping serves as a control for the study and were used to weigh up the results of the GBL group and the traditional teaching group in terms of significant knowledge gains from the learning intervention.

The second grouping was the grouping educated by GBL by using the game Code Combat (see par 3.5) which is an internationally recognised open source game that can teach different programming languages. Within this grouping the participants had to complete the first “island” of the game and this taught them the basics of JavaScript as well as loops and conditional statements. Within this grouping 18 ($n=18$) participant completed the study.

The third grouping was educated in the traditional lecture-student classroom setup and taught JavaScript from open source notes entitled “JavaScript for Beginners” that was downloaded from wintrstein.me.uk. Participants had one class a week from 27 April 2016 to 24 June 2016, within this time the basics of JavaScript was taught to the participant in the traditional classroom setup; students had to follow along with the lecturer and had to complete small exercises such as coding a loop or a conditional statement. The third group had a total of 17 ($n=17$) participants that completed the experiment.

Due to the small sample size the groups did not have an equal distribution of first, second, and third year students. A sample of 47 CIS students were drawn from the MA ($n=47$) using

the convenient sampling method. Convenience sampling is the most commonly used sampling technique within research. This technique was used for the study because the participants were readily available and were all volunteers. The advantages thereof being that all the participants were available and willing to partake in the research experiment.

Before the research experiment could commence all participants gathered in a lecture room where the purpose of the study was explained and written consent was obtained by using consent forms. Thereafter the pretest (see par 3.6) was written by all participants. After the learning intervention (which was playing Code Combat by the second grouping, and teaching JavaScript to the third grouping) took place, the posttest was written which was in the exact same form as the pretest and contained the same type of questions. This assessment tested all the content that was taught to students during the learning intervention.

3.6. Code Combat

The game used for the study is called Code Combat, which teaches the player how to code in one of five different programming languages. The player can choose to code Python (a Zen-like scripting language), JavaScript (seen as the language of the web), CoffeeScript (language that is based on JavaScript), Clojure (a modern lisp), and Lua (game scripting language). For the study the participants were taught JavaScript, which is in close relation to the Java programming language that first year CIS students are taught at the MA.

The game is a free-to-play, open source, online game and the only thing that a player must do to play is create a username and password. A person of any age grouping can play the game, there are no limitations with regards to age, gender, or geographical location. Within the game the player's character has upgrades in the form of armour and weaponry and this then unlocks new programming code for the player to use within the different stages of the game. The game also has international leader boards of all the top players in the world.

Furthermore, there are three main stages in the game that are presented to the player as chapters. The first, called Kithgard Dungeon is between one and three hours of play. The lessons learned within the chapter is syntax, methods, parameters, strings, loops and variables all on a basic entry level. The second chapter called Backwoods Forest is between two and six hours of play and teaches the player conditional statements, relational operators, object properties and input handling. The third chapter called Sarven Desert is between 4 to eleven hours of game play and teaches the player arithmetic, counters, while loops, break, arrays, string comparison, and finding min/max values. Participant did not have to complete all the stages within each chapter of the game, and thus did not need all the time as allocated by the game itself.

3.7. Materials

Both the pretest and posttest were set up in paper form and all answers from participants had to be hand-written. The tests tested participants' JavaScript knowledge before and after the intervention took place.

Before the tests could be used for the study, the test materials went through approval by the CIS department lecturers and chairperson, the study supervisors, following normal procedures at the University of Stellenbosch, and with informed consent from the participants themselves.

Materials needed for the study included; paper to print the pretest, posttest, paper based learning aids for group 3, and a lecture room in the form of a computer laboratory with a Local Area Network (LAN). The lecture room needed a workstation with a working internet connection for every participant in group 2 and group 3. All workstations needed to have a Java-enabled web browser so that participants could code and compile scripts online.

3.8. Procedure

The second phase of the study included the execution of the experiment. The experiment was conducted over the period 27 April to 23 June 2016. The experiment was conducted during the first semester of the academic year. Before the second part of the study continued the LAN was tested with the necessary computer hardware and software, the participants were allocated to the different groupings of the study. All the participants within the GBL grouping then registered their accounts on the Code Combat website for the experiment to commence. During each period of play, the participants were required to complete a certain amount of levels that took no longer than 45 minutes (a standard teaching period) at a time.

The experiment was conducted in a pretest-posttest design, and required all three groupings of students to write an examination on general knowledge of JavaScript. After this pretest the teaching grouping was taught in the conventional lecturer-student classroom setup, and the GBL group was taught the exact same subject matter by playing Code Combat.

After teaching JavaScript to the two groupings, the posttest was written on their general knowledge of JavaScript and these results were then used to calculate the gain scores for every participant, and to test the difference in gain scores between the three groupings. The gain score formulae used was as follows: $\frac{(Pretest-Posttest)}{(100\%-Pretest)}$. From this results it should be clear if the students do better in a GBL setup or in the traditional lecturer-student classroom setup.

The data collected from the tests were used to calculate the gain scores and descriptive statistical analysis were conducted on the data to determine if GBL had a significantly higher learning gain than traditional lecturer-student classroom setup.

3.9. Statistical analysis

Learning gain scores were used to gather information with regards to the difference in the pretest and posttest scores. Descriptive statistics along with single factor ANOVA were used to determine if the difference in the learning gain scores between the groupings were significant and if GBL is feasible as a teaching solution at the MA.

The ANOVA test is the initial step in identifying factors that are influencing a given data set. After the ANOVA test is performed, the analyst can perform further analysis on the systematic factors that are statistically contributing to the data set's variability (Williams, Sweeney, & Anderson, 2012). An alpha level of 0.05 was set to test the hypothesis.

Furthermore, descriptive statistics were adopted using percentages, means, minimums, maximums and standard deviations. This allowed for graphical representation of the statistics conducted on the data.

3.10. Summary

This chapter presented a detailed discussion on the procedure used within the experiment, the research methodology used within the study, and an overview of the research design, the participants and the analytical methods used to represent the data. An overview of the statistical analysis was provided in this chapter. The next chapter will report the statistical analysis results for the study.

CHAPTER 4

RESULTS

4.1. Introduction

Within Chapter 1 the need to address the research problem (see par 1.2), and to satisfy the research objectives (see par 1.4) resulted in the formulation of the research hypothesis (see par 1.5). In Chapter 2 the theoretical underpinning was discussed along with the focus of the study. Chapter 3 dealt with the research methodology and how the research experiment was conducted (see par 3.7). This chapter presents the learning gain scores calculated for each participant including the various statistical analysis conducted on the data from the three groups. The results of the study are presented by showing the difference in learning gain scores of the individuals, as well as descriptive statistics for the groupings. To test the significance of the results, Single factor Analysis of Variance was performed on the data. From the statistical analysis conducted on the data the research hypotheses are accepted or rejected.

4.2. Descriptive statistics of the sample

Participants in this study included a sample of 47 CIS enrolled residential students at the Military Academy within the South African National Defence Force (SANDF). The participants were from three of the four Arms of Service within the SANDF; SA Navy, SA Army and SA Air Force.

The Participants consisted of 85% Males and 15% Females. Participants were aged between 19 and 35 with 47% between the ages of 19 and 24, 49% between the ages of 25 to 30, the remaining 4% were over 31 years of age. Within the sample 40% of the participants were SA Navy, 43% SAAF, 17% SA Army. The majority of the participants (57%) had no previous programming experience. No personal information such as marital status or corps mustering was gathered, and no gender specific statistics were conducted due to the small percentage of female participants.

4.3. Validity and reliability of questionnaires

4.3.1. Validity

Validity is the ability of an instrument to measure what it is intended to measure. It is the degree to which a researcher has measured what was set out to be measured (Kumar, 2011, p. 178). Validity is the extent to which an empirical measure adequately reflects the real measuring of the concept being researched. Validity is mainly considered to investigate whether the research being conducted is providing the answers to the research questions, and in doing so ensure that the correct procedures are used.

The questionnaires used were in the form of tests that only included questions on JavaScript. The tests were moderated by the CIS department lecturers, and the chairperson before they were edited and submitted to the University of Stellenbosch's ethics committee for clearance. Administering of the two tests was done only after ethical clearance was obtained from the committee.

4.3.2. Reliability testing

Reliability refers to the consistency, or stability of test scores when the measurement procedure is administered repeatedly to groups of examinees (Setzer & He, 2009, p. 2). Reliability of tests are inversely related to the amount of measurement error in test scores, meaning that the more measurement error the less reliable the test. Reliability can be measured by using several evaluation procedures. For this study the Kuder-Richardson Coefficient of reliability (KR 20) was used to test the internal reliability of the tests administered. KR 20 is used to test the reliability of binary measurements such as exam questions, to test if the items within the questionnaire (or examination) obtained the same results over the whole participant sample that the test was administered to (Setzer & He, 2009, p. 8).

To test the reliability of the pre- and posttest a binary measurement was used, if a participant had the question right a 1 was allocated, if the answer was wrong a 0 was allocated.

The KR20 coefficient ranges from 0 to 1, with results closer to 1 indicating the tests are reliable. The results indicated acceptable internal reliability of the pretest (KR20 = 0.75). The results also indicated that the internal reliability of the posttest was acceptable (KR 20 = 0.67). Indicating that the tests used were reliable in testing the participants' JavaScript knowledge before, and after the learning intervention.

4.4. Learning Gain Scores for the groupings

Per McGrath, et al (2015) the term learning gain is understood in a variety of ways within higher education. It is understood as the difference in student performance between two stages of their studies, as a variant of the concept learning (McGrath, Guerin, Harte, Frearson, & Manville, 2015). Furthermore learning gain in higher education is seen as the difference in skills, competencies, content knowledge and/or personal development demonstrated by a student in two different points in time (McGrath, Guerin, Harte, Frearson, & Manville, 2015, p. xi). For the purpose of this study the term learning gain is used as the difference in performance of the participants before and after the learning intervention.

The learning gains score for each group have been sorted from highest to lowest individual pretest scores. This will not necessarily result in the highest to lowest posttest, or gain scores.

4.4.1. Gain scores for group 1 - control

The total participants that completed both the pretest and posttest equalled 12; 8 participants' data was removed due to incomplete data. Participants consisted of 66.67% males and 33.33% females. Participants were aged between 19 and 35 with 41.67% between the ages of 19 and 24, 50% between the ages of 25 to 30, and 8.33% older than 31. The participants were from three different Arms of Service with 8.33% from SAN, 41.67% SAAF, and 41.67% SAA. Group one had an equal representation of year groups, 33.33% first year students,

33.33% second year students, 33.33% third year students. The percentages shown in Table 3 are test score results obtained by participants.

Group one showed an average gain score of 0.07 (7%) positive gain within the time period of the experiment (see Table 3). The gain scores ranged from 7% to 36%.

Table 3

Gain Scores for Group 1

Year	Pretest-%	Posttest-%	Gain Scores
1	68,889	66,667	-0,07
1	55,556	57,778	0,05
1	35,556	37,778	0,03
1	26,667	26,667	0
2	42,222	51,111	0,15
2	31,111	26,667	-0,06
2	20	28,889	0,11
2	8,889	13,333	0,05
3	75,556	84,444	0,36
3	42,222	48,889	0,12
3	24,444	24,444	0
3	17,778	22,222	0,05
Average Gain Score			0,07

Note. Year reflects the current academic year of study, 1 is for first year, 2 for second year, and 3 for third year.

4.4.2. Gain scores for group 2 - GBL

The total participants that completed both the pretest and posttest equalled 18, 4 participants' data was removed due to incomplete data. Only male participants completed the experiment in group 2. Participants were aged between 19 and 34 with 66.67% between the ages of 19 and 24, 27.78% between the ages of 25 to 30, and 5.56% between 31 and 34. Three Arms of Service were represented within group 2; 77.78% SAN, 16.67% SAAF, and 5.56% SAA. Participants were from all three year groups with 38.89% first year students, 33.33%

second year students, and 27.78% third year students. All percentages shown in Table 4 are test score results obtained by participants for the pretest and posttest.

Result show group 2 (see Table 4) had an average learning gain score of 0.33 (33%) positive gain during the research experiment. Gain scores ranged from 8% to 81%.

Table 4

Gain Scores for Group 2

Year	Pretest-%	Posttest-%	Gain Scores
1	75,556	84,444	0,36
1	60	73,333	0,33
1	44,444	55,556	0,2
1	42,222	64,444	0,38
1	37,778	57,778	0,32
1	33,333	55,556	0,33
1	31,111	86,667	0,81
2	71,111	80	0,31
2	57,778	64,444	0,16
2	46,667	60	0,25
2	40	57,778	0,3
2	31,111	68,889	0,55
2	26,667	53,333	0,36
3	75,556	86,667	0,45
3	42,222	46,667	0,08
3	37,778	51,111	0,21
3	28,889	48,889	0,28
3	28,889	53,333	0,34
Average Gain Score			0,33

Note. The table is divided into year groups, 1 is first year participants, 2 is for second year participants, and 3 is for third year participants.

4.4.3. Gain scores for group 3 – traditional teaching

The total participants within group 3 that completed the experiment equalled 17; 3 participants did not complete the posttest and their data was removed.

Participants in group 3 consisted of 88.23% males and 11.76% females. Participants were aged between 19 and 30 with 29.41% between the ages of 19 and 24, and 70.59% between the ages of 25 to 30. Three Arms of Service were represented within group 3; 23.53% SAN, 64.71% SAAF, and 5.88% SAA. Participants were from all three year groups with 64.71% first year students, 17.65% second year students, and 17.65% third year students. All percentages shown in Table 5 are test score results obtained by participants for the pretest and posttest.

Result show group 3 (see Table 5) had an average learning gain score of 0.34 (34%) positive gain during the research experiment. Gain scores ranged from 4% to 59%.

Table 5

Gain Scores for Group 3

Year	Pretest-%	Posttest-%	Gain Score
1	37,778	53,333	0,25
1	33,333	42,222	0,13
1	28,889	48,889	0,28
1	28,889	46,667	0,25
1	26,667	53,333	0,36
1	26,667	44,444	0,24
1	22,222	51,111	0,37
1	22,222	64,444	0,54
1	15,556	48,889	0,39
1	11,111	46,667	0,4
1	8,889	62,222	0,59
2	62,222	80	0,47
2	60	73,333	0,33
2	40	60	0,33
3	57,778	64,444	0,16
3	51,111	68,889	0,36
3	44,444	62,222	0,32
Average Gain Score			0,34

4.5. Significance testing

4.5.1. Group 1 – Control

The results for group 1 (see Table 6) ranged from 8.89% to 75.56% for the pretest ($M = 37.41$, $SD = 20.56$), and ranged from 13.33% to 84.44% for the posttest ($M = 40.74$, $SD = 21.22$).

Table 6

Descriptive Analysis of Pretest and Posttest Scores for Group 1

	Pretest-%	Posttest-%
Mean	37,41	40,74
Standard Error	5,94	6,12
Median	33,33	33,33
Mode	42,22	26,67
Standard Deviation	20,56	21,22
Sample Variance	422,75	450,13
Range	66,67	71,11
Minimum	8,89	13,33
Maximum	75,56	84,44
Count	12,00	12,00

Referring to Table 7, an analysis of variance showed that the difference between the pretest and posttest was not significant for the participants in group 1, $F(1, 22) = 0.15$, $p > .05$.

Table 7

ANOVA for the Difference in Pretest and Posttest Scores of Group 1

ANOVA: Single Factor					
SUMMARY					
Groups	Count	Sum	Average	Variance	
Pretest-%	12	448,89	37,4075	422,7498	
Posttest-%	12	488,889	40,7408	450,1313	
ANOVA					
Source of Variation	SS	df	MS	F	P-value
Between Groups	66,6633	1	66,6633	0,1527	0,6997
Within Groups	9601,6917	22	436,4405		
Total	9668.3550	23			

4.5.2. Group 2 - GBL

The results (see Table 8) ranged from 46.67% to 86.67% for the posttest ($M = 63.83$, $SD = 13.22$), and were significantly higher (see Table 9) than the results of the pretest that ranged from 26.67% to 75.56% ($M = 45.06$, $SD = 16.20$).

Table 8

Descriptive Analysis of Pretest and Posttest Scores for Group 2

	Pretest-%	Posttest-%
Mean	45,06	63,83
Standard Error	3,82	3,12
Median	41,11	58,89
Mode	75,56	86,67
Standard Deviation	16,20	13,22
Sample Variance	262,49	174,76
Range	48,89	40,00
Minimum	26,67	46,67
Maximum	75,56	86,67
Count	18	18

Analysis of variance (see Table 9) showed the GBL learning intervention had a significant influence on the learning gain of the participants in the GBL group (group 2), $F(1, 34) = 14.49$, $p < .05$.

Table 9

ANOVA for the Difference in Pretest and Posttest Scores of Group 2

ANOVA: Single Factor					
SUMMARY					
Groups	Count	Sum	Average	Variance	
Pretest-%	18	811,1121	45,0618	262,4899	
Posttest-%	18	1148,889	63,8272	174,7592	
ANOVA					
Source of Variation	SS	df	MS	F	P-value
Between Groups	3169,257	1	3169,2565	14,4963	0,0006
Within Groups	7433,235	34	218,6246		
Total	10602,49	35			

4.5.3. Group 3 – Traditional teaching

The results (see Table 10) ranged from 42.22% to 80% for the posttest ($M = 57.12$, $SD = 10.88$), and was significantly higher (see Table 11) than the pretest results that ranged from 8.89% to 62.22% ($M = 33.99$, $SD = 16.63$).

Table 10

Descriptive Analysis of Pretest and Posttest Scores for Group 3

	Pretest-%	Posttest-%
Mean	33,99	57,12
Standard Error	4,03	2,64
Median	28,89	53,33
Mode	28,89	46,67
Standard Deviation	16,63	10,88
Sample Variance	276,40	118,37
Range	53,33	37,78
Minimum	8,89	42,22
Maximum	62,22	80,00
Count	17,00	17,00

Analysis of variance (see Table 11) indicate that the traditional teaching learning intervention had a significant influence on the learning gain scores of the participants in the traditional teaching group (group 3), $F(1, 32) = 23.05, p < .05$.

Table 11

ANOVA for the Difference in Pretest and Posttest Scores of Group 3

ANOVA: Single Factor					
SUMMARY					
Groups	Count	Sum	Average	Variance	
Pretest-%	17	577,778	33,9870	276,3960	
Posttest-%	17	971,109	57,1241	118,3721	
ANOVA					
Source of Variation	SS	df	MS	F	P-value
Between Groups	4550,2728	1	4550,2728	23,05289	0,00004
Within Groups	6316,2894	32	197,3840		
Total	108866.5622	33			

4.5.4. Differences between group 1 and group 2 gain scores

Results (see Table 12) indicate the learning gain scores of group 2 ranging from 8% to 81%, ($M = 0.33$, $SD = 0.16$) are significantly higher than the learning gain scores of group 1 that ranged from -7% to 36%, ($M = 0.07$, $SD = 0.11$).

Table 12

Descriptive Statistics for Group 1 and Group 2

	Group 1 Gain Scores	Group 2 Gain Scores
Mean	0,07	0,33
Standard Error	0,03	0,04
Median	0,05	0,33
Mode	0,05	0,36
Standard Deviation	0,11	0,16
Sample Variance	0,01	0,03
Range	0,43	0,73
Minimum	-0,07	0,08
Maximum	0,36	0,81
Count	12,00	18,00

The analysis of variance (see Table 13) indicate a significant difference between the learning gain scores of the control group (group1) and the GBL group (group 2), $F(1, 28) = 25.35$, $p < .05$.

Table 13

ANOVA for the Difference in Learning Gain Scores of Group 1 and Group 2

ANOVA: Single Factor					
SUMMARY					
Groups	Count	Sum	Average	Variance	
Group 1 Gain Scores	12	0,79	0,0658	0,0130	
Group 2 Gain Scores	18	6,02	0,3344	0,0253	
ANOVA					
Source of Variation	SS	df	MS	F	P-value
Between Groups	0,5195	1	0,5195	25,3528	0,00003
Within Groups	0,5737	28	0,0205		
Total	1.0932	29			

Referring to Figure 3, the difference in learning gain scores is clearly visible. Participants in group 2 had higher learning gain scores than participants in group 1.

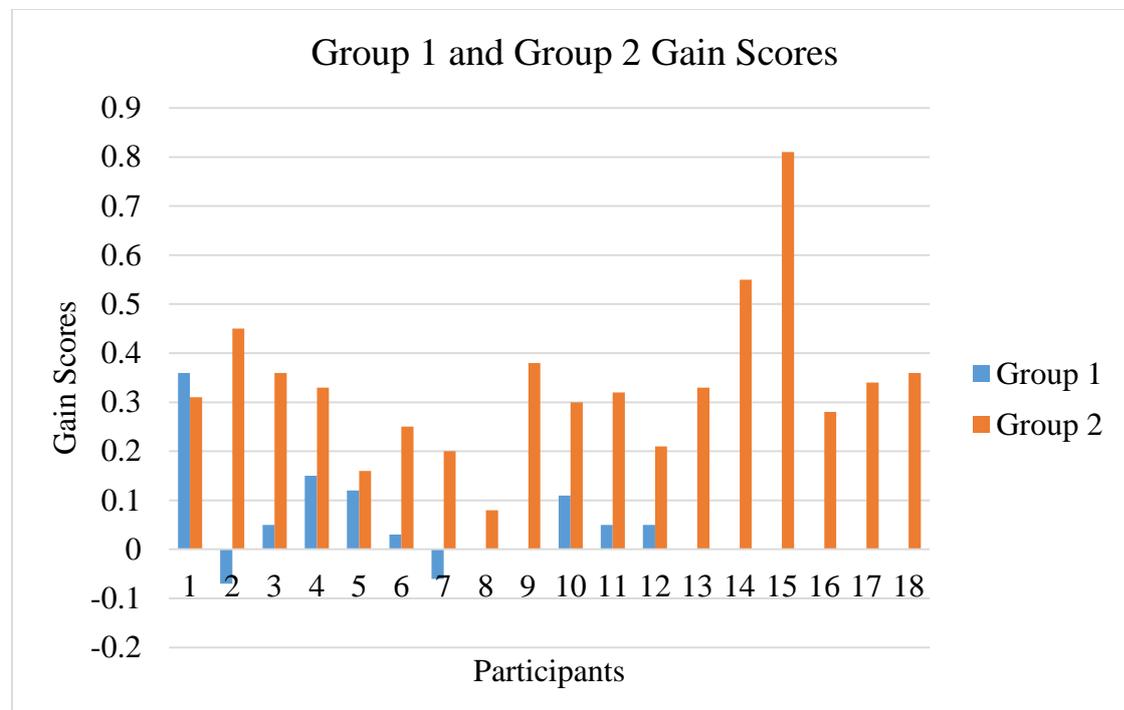


Figure 3. Group 1 and Group 2 Gain Scores.

4.5.5. Differences between group 1 and group 3 gain scores

Results (see Table 14) indicated that the learning gain scores of the traditional teaching group (group 3), ($M = 0.34$, $SD = 0.12$) are significantly higher (see Table 15) than the learning gain scores of the control group (group 1), ($M = 0.07$, $SD = 0.11$).

Table 14

Descriptive Statistics for Group 1 and Group 3 Learning Gain Scores

	Group 1 Gain Scores	Group 3 Gain Scores
Mean	0,07	0,34
Standard Error	0,03	0,03
Median	0,05	0,33
Mode	0,05	0,33
Standard Deviation	0,11	0,12
Sample Variance	0,01	0,01
Range	0,43	0,46
Minimum	-0,07	0,13
Maximum	0,36	0,59
Count	12,00	17,00

Analysis of variance (see Table 15) indicate a significant difference in the learning gain scores of group 1 and group 3, $F(1, 27) = 37.65$, $p < .05$.

Table 15

ANOVA for the Difference in Learning Gain Scores of Group 1 and Group 3

ANOVA: Single Factor					
SUMMARY					
Groups	Count	Sum	Average	Variance	
Group 1 Gain Scores	12	0,79	0,0658	0,0130	
Group 3 Gain Scores	17	5,77	0,3394	0,0146	
ANOVA					
Source of Variation	SS	df	MS	F	P-value
Between Groups	0,5265	1	0,5265	37,6482	0,000001
Within Groups	0,3776	27	0,0140		
Total	0,9041	28			

Referring to Figure 4, differences in learning gains scores between group 1 and group 3 indicate that participants in group 3 had higher learning gain scores than participants in group 1.

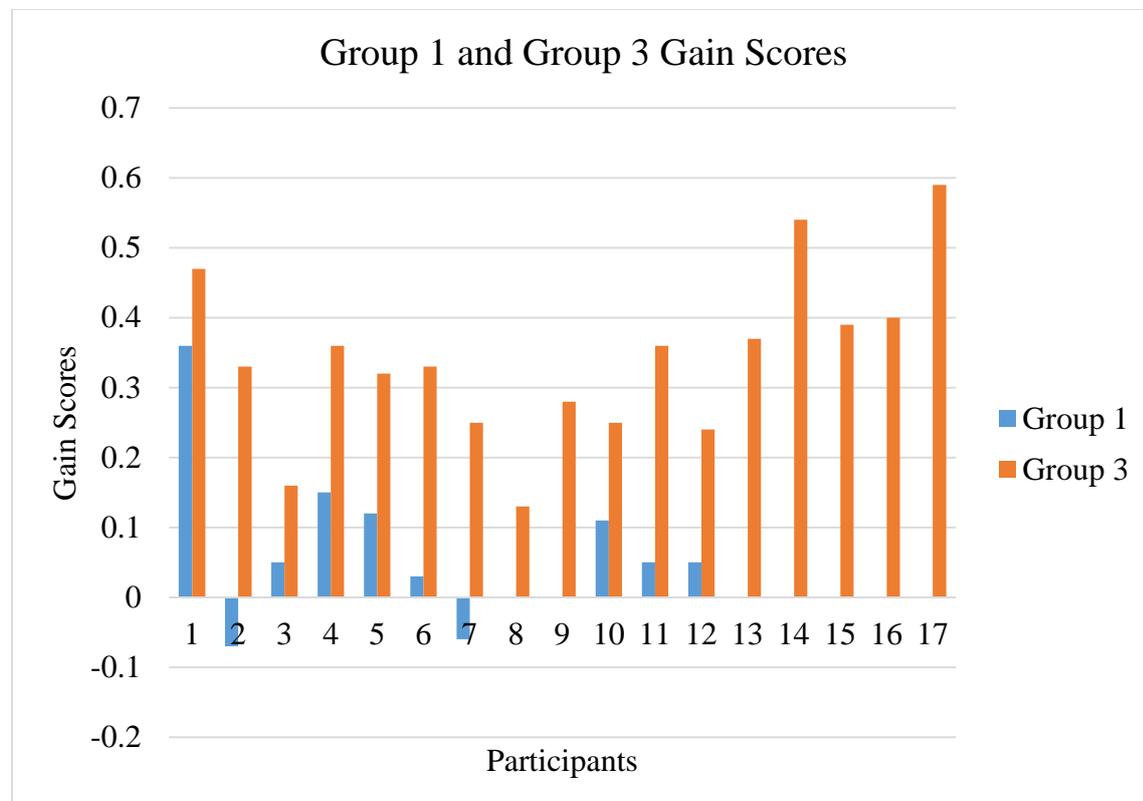


Figure 4. Group 1 and Group 3 Gain Scores.

4.5.6. Difference between group 2 and group 3 gain scores

Results (see Table 16) indicated the learning gain score for the GBL group (group 2), ($M = 0.33$, $SD = 0.16$), and the traditional teaching group (group 3), ($M = 0.34$, $SD = 0.12$) are not significantly different.

Table 16

Descriptive Statistics for Group 2 and Group 3 Learning Gain Scores

	Group 2 Gain Scores	Group 3 Gain Scores
Mean	0,33	0,34
Standard Error	0,04	0,03
Median	0,33	0,33
Mode	0,36	0,33
Standard Deviation	0,16	0,12
Sample Variance	0,03	0,01
Range	0,73	0,46
Minimum	0,08	0,13
Maximum	0,81	0,59
Count	18,00	17,00

Analysis of variance (see Table 17) indicated that there was no significant difference in the learning gains scores of group 2 and group 3, $F(1, 33) = 0.01$, $p > .05$.

Table 17

ANOVA for the Difference in Learning Gain Scores of Group 2 and Group 3

ANOVA: Single Factor					
SUMMARY					
Groups	Count	Sum	Average	Variance	
Group 2 Gain Scores	18	6,02	0,3344	0,0253	
Group 3 Gain Scores	17	5,77	0,3394	0,0146	
ANOVA					
Source of Variation	SS	df	MS	F	P-value
Between Groups	0,0002	1	0,0002	0,0107	0,9182
Within Groups	0,6643	33	0,0201		
Total	0,6646	34			

Referring to Figure 5, the differences in learning gain scores of the participants in group 2 and group 3 indicate that the two groups had similar learning gain scores for the research experiment.

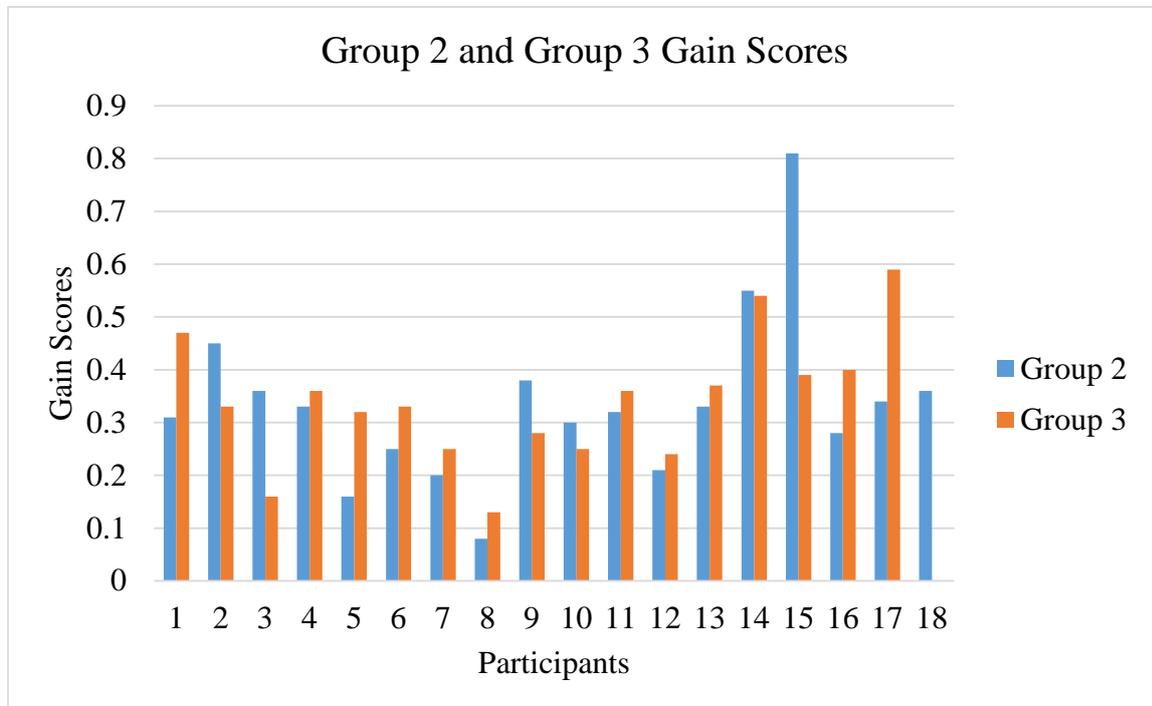


Figure 5. Group 2 and Group 3 Gain Scores.

4.5.7. Differences between the control group, GBL group, and traditional teaching group

Analysis of variance (see Table 18) indicated that there is a significant difference between the learning gain scores of the control group, GBL group, and traditional teaching group, $F(2, 46) = 17.8818$, $p < 0.05$. This result does not indicate between which variables a significant difference lies. Tukey's honestly significant difference (HSD) test was conducted for further analysis.

Table 18

ANOVA for the Difference in Learning Gain Scores of Group 1, Group 2, and Group 3

ANOVA: Single Factor					
SUMMARY					
Groups	Count	Sum	Average	Variance	
Group 1	12	0,79	0,0658	0,0130	
Group 2	18	6,02	0,3344	0,0253	
Group 3	17	5,77	0,3394	0,0146	
ANOVA					
Source of Variation	SS	df	MS	F	P-value
Between Groups	0,6566	2	0,3283	17,8818	0,0000020713
Within Groups	0,8078	44	0,0184		
Total	1,4644	46			

Using the Tukey's HSD test ($HSD = q\sqrt{MSw/n}$) where q is the standardised range q , MSw is the mean square within and n is the number of participants in each category, $HSD = 0.0679$. This indicates that the learning gain scores mean of each group must differ at least 6.79% to be significant. Results (see Table 19) indicate a significant difference in learning gain scores between the GBL group and the control group, as well as the traditional teaching group and the control group.

Table 19

Tukey's HSD test for difference in samples

Group	Mean	Difference from group 3	Difference from group 2
Traditional	0,3394		
GBL	0,3344	0,0050	
Control	0,0658	0,2736	0,2686

Note. Groups are in descending order according to the mean values.

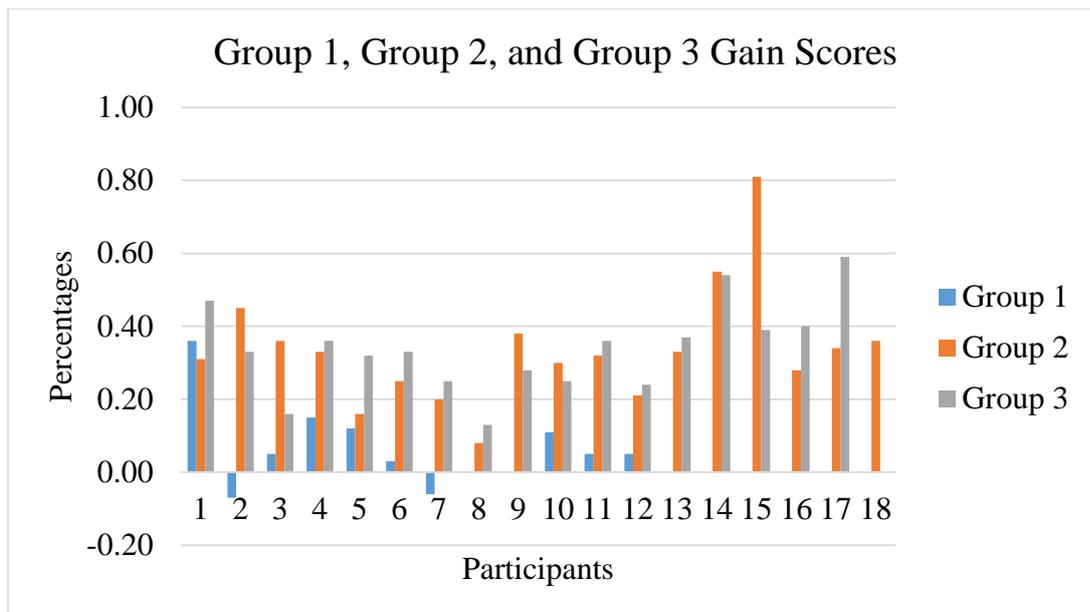


Figure 6. Group 1, Group 2, and Group 3 Gain Scores.

4.5.8. Hypothesis of the study

- H1: Game Based Learning results in significantly higher learning gain scores than traditional teaching.

From Table 17 it can be seen that the results showed the gain score was lower for GBL ($M = 0.33$, $SD = 0.16$) than for traditional teaching methods ($M = 0.34$, $SD = 0.12$). Analysis of variance (see Table 4.14) showed no significant difference in the results, $F(1, 33) = 0.01$, $p > .05$. H1 was rejected.

- H2: There is a significant positive gain in knowledge when GBL is used as teaching method.

Results from Table 8 showed a significant difference in the pretest and posttest scores, $F(1, 34) = 14.49$, $p < .05$. Results from the posttest ($M = 63.83$, $SD = 13.22$) were significantly higher than the results of the pretest ($M = 45.06$, $SD = 16.20$). H2 was accepted.

- H3: There is a significant positive gain in knowledge if traditional teaching is used as a teaching method.

Results from Table 10 indicate a significant difference in the pretest and posttest scores of group 3, $F(1, 32) = 23.05, p < .05$. Indicating that the test scores of the posttest ($M = 57.12, SD = 10.88$) were significantly higher than the pretest scores ($M = 33.99, SD = 16.63$). H3 was accepted.

• H4: There is a significant difference in the traditional classroom teaching and GBL learning gain scores.

Analysis of variance (see Table 16) results indicates no significant difference in the learning gains scores of the two groups, $F(1, 33) = 0.01, p > .05$. H4 was rejected.

4.6. Summary

The purpose of the chapter was to report the different statistical analysis that were performed on the data obtained from the studies' experiment. Learning gain scores were reported for each student to show the difference in knowledge from the pretest and the posttest. Reportedly group 1 had a positive average gain score of 0.07 (7%), indicative that the group one participants gained 7% knowledge on average within the experimental period without any formal intervention taking place. Group 2 had a positive average gain score of 0.33 (33%), reporting that participants in group two gained on average 33% more knowledge than what they had before the study. Within Group 3 the highest average gain score of the study was recorded at 0.34 (34%), indicating that within the traditional teaching group participants gained 34% more knowledge than what they had on average.

Descriptive statistics were reported for each grouping to show the difference in scores achieved by the groupings. Group 1 results indicated a range of 8.89% to 75.56% ($M = 37.41, SD = 20.56$) for the pretest, and a range of 13.33% to 84.44% ($M = 40.74, SD = 21.22$). Group 2 results indicated a range of 26.67% to 75.56% ($M = 45.06\%, SD = 16.20$) for the pretest and a range of 46.67% to 86.67% ($M = 63.83, SD = 13.22$) for the posttest. Moreover, group 3

results indicated a range of 9% to 62.22% ($M = 33.99$, $SD = 16.63$) for the pretest and a range of 42.22% to 80% ($M = 57.12$, $SD = 10.88$) for the posttest.

Single factor analysis of variance was conducted on the data gathered for the three groupings to show significant differences in test scores obtained in all three groupings. Group 1 showed no significant difference between the pretest and posttest, $F(1, 22) = 0.15$, $p > .05$. Group 2 showed significant differences between the two tests, $F(1, 34) = 14.49$, $p < .05$. Group 3 also showed significant differences between the two tests, $F(1, 32) = 23.05$, $p < .05$.

The statistical analysis showed that GBL and traditional teaching were both effective teaching methods, and that there is no statistically significant difference between GBL and traditional teaching methods within the experimental perimeters of the study, $F(1, 33) = 0.01$, $p > .05$ (see Figure 5 and Table 17).

This result indicates that there is no statistically significant difference when GBL or traditional teaching methods are used to teach undergraduate student at the MA. As a result the following hypothesis were accepted: H2, and H3.

CHAPTER 5

DISCUSSION, CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

5.1. Introduction

This chapter aims to discuss the research results in Chapter 4. This chapter also aims to set out the limitations of the study as well as the recommendations for future research. The chapter will proceed with a discussion on the learning gains achieved by the participants of the study. Further discussions will be on the significance of the results within the different groupings between the groupings and the dependent variable (Student Learning Gain Scores). A discussion on the limitations of the study, and recommendations for future research will conclude the chapter.

The study was conducted in an attempt to answer three questions; the one most focused on was “Can GBL be used effectively as a teaching method at the MA?” The primary purpose was to conduct an experiment in order to test if GBL will be a well-suited teaching method at the MA. In what follows, the main findings and their implications are discussed.

5.2. Discussion on gain score results

The aim of the study was to show that GBL could result in significantly better learning gain scores than traditional teaching methods within higher education specifically at the MA, and to show that GBL can be used as a feasible teaching method within the MA.

To achieve this, research hypotheses were formulated (see par 1.6). Although not all results relating to these hypotheses were accepted, the study brought some insight into understanding that GBL can be a feasible and effective teaching method within the MA.

Gee (2009), puts emphasis on the potential that games have in being good teachers and in facilitating the learning process. Superb games and GBL games are built on acceptable learning principles that are supported by current research in the cognitive sciences (Gee, 2009,

p. 68). These principles enhance the learning process by teaching the player how the game functions in a seamless way.

Anetta (2008), explains that the current student generation is different than previous generations and they learn differently (Anetta, 2008). Students react differently than their previous cohorts to traditional teaching methods, and are growing up with technology at their fingertips (Balance, 2013; Cant & Bothma, 2010). The nature of higher education is changing and different pedagogical models need to be implemented to ensure students are taught effectively and can retain that knowledge.

Future generations of educators must focus more on how they facilitate the learning experience than educators of today. This will require the ability to adapt to different teaching styles and using different pedagogies such as GBL to teach the subject matter.

The study participants (see par 3.4) were divided into three groupings. All three groups had participants from all three of the year groups of the MA. After the research experiment (see par 3.7) was conducted the learning gain scores of the different groupings needed to be calculated to statistically analyse the resulting learning gains of each individual after the intervention took place. This was calculated using a learning gain formula (see par 3.7).

Group 1 was used as the control group of the study (see par 3.2) and did not receive any intervention. Learning gain score results indicated that group one had an overall positive learning gain of 0.07 (7%) during the experimental period. This can be due to different circumstances not foreseen within the experimental perimeters. Further statistical analysis were conducted (see par 4.5.1) to investigate whether there was significant gain in knowledge.

Group 2 was the GBL group and received a learning intervention by playing Code Combat (see par 3.5). The GBL lessons provided the participants with the opportunities to discuss and practice new concepts of the JavaScript language within an interactive game environment. Per the calculated gain scores, the group had a positive gain of 0.33 (33%) in

knowledge during the experimental period. Further statistical analysis (see par 4.5.2) was conducted in order to see if the positive gain in knowledge is indeed significant.

Participants in group 3 were taught using traditional teaching methods and showed an average gain of 0.34 (34% positive gain). If the results prove that the learning gain scores of group 3 are significant it proves that traditional teaching is still an effective teaching method within the MA.

5.3. Discussion on significance testing

H2 stating that there is a significant positive gain in knowledge when GBL is used as a teaching method was accepted. The results (see Table 4.6) showed that group 2 had significant positive learning gain scores, $F(1, 34) = 14.49, p < .05$. Results from the posttest ($M = 63.83, SD = 13.22$) were significantly higher than the results of the pretest ($M = 45.06, SD = 16.20$). These results indicate that students within the educational environment of the MA can be taught a significant amount of knowledge by using GBL as a teaching method. Indicating that GBL is a feasible option for teaching CIS students at the MA.

H3 stating that there is a significant positive gain in knowledge when traditional teaching is used as teaching method was accepted. Results from Table 4.8 indicate a significant difference in the pretest and posttest scores of group 3, $F(1, 32) = 23.05, p < .05$. Indicating that the test scores of the posttest ($M = 57.12, SD = 10.88$) were significantly higher than the pretest scores ($M = 33.99, SD = 16.63$). The results indicate that traditional teaching methods as used by the clear majority of the MA is still an effective way of teaching undergraduate students at the MA.

Further analysis on the results obtained from the three different groups indicated that only group2 and group 3 had significant differences between the results of the pretest and the posttest. Analysis of variance results indicated that there was no significant difference in the test scores of group 1, $F(1, 22) = 0.15, p > .05$. Group 1 was used as the control group of the

study, and these findings indicate that for group 1 no significant intervention took place during the research experiment timeline.

Analysis of variance for the learning gain score results of group 1 and 2 indicated a significant difference in the learning gain scores of the two groups, $F(1, 28) = 25.35, p < .05$. This indicates that participants in group 2 had significantly higher learning gain scores than participants in group 1. The results serve to support the findings that GBL can be used as a teaching method at the MA.

Analysis of variance for the learning gain scores of group 1 and group 3 indicated a significant difference in the learning gain scores of the two groups, $F(1, 27) = 37.65, p < .05$. The results indicate that traditional teaching methods currently used at the MA are still adequate to teach CIS students at the MA.

H4 stating that there is a significant difference between the traditional teaching and GBL learning gain scores along with H1 stating that GBL results in significantly higher learning gain scores than traditional teaching was rejected. The results indicated that there is no significant difference between when traditional teaching methods or GBL are used to teach CIS student at the MA, $F(1, 33) = 0.01, p > .05$. These results point out that within the research experiment of the study GBL and traditional teaching methods are equally adequate for teaching CIS students at the MA. Moreover, the results indicate that GBL is neither significantly better nor significantly worse than traditional teaching methods to teach students at the MA, making it a feasible method of teaching within the CIS modules at the MA. The high learning gain scores are indicative that GBL can be used as a teaching method within the MA.

The findings hold some practical implications for educators; distance education can use a system where students can be taught subject matter without the need for contact sessions,

educators can make use of a combined lesson plan where GBL, e-learning and traditional teaching methods are all used to teach students.

Furthermore, the findings hold potential benefits for teaching within the CIS modules and ultimately the MA. The nature of the technological changes in education was explained within chapter 2 (see par 2.2). Students studying CIS at the MA being taught by using GBL can possibly perform as well as students being taught by using traditional teaching methods. They will be able to understand the work just as well as their counterparts. This will enable them to learn within an interactive and engaging environment (Anetta, 2008).

5.4. Summary

The results of this study include the significant learning gain scores obtained through using GBL and traditional teachings. Significant differences were found in the learning gain scores of the GBL group and the control group indicating GBL does facilitate learning in a positive way. Traditional teaching methods were found to be still adequate in teaching CIS students at the MA. No significant difference was found between GBL and traditional teaching, indicating that GBL can be used at the MA and could provide students with enough knowledge. These results of the significant positive learning gains will provide educators at the MA with enough data to use GBL in the future at the MA.

5.5. Conclusions

The integration of learning technology into higher education necessitates a shift in the ways educators teach students. The current student generation are more technologically advanced than ever before. Students use Information Technology daily and learn differently than previous generations (see Chapter 2). This demands a different stimulation of students in terms of interacting, and engaging with subject matter in such a way that students can process and use the knowledge they gain through the education they receive. Technology being used

to teach requires a different educator profile, one where educators can adapt to new technology and use it effectively.

The study evaluated the learning effectiveness of using GBL as teaching method, to teach undergraduate CIS students at the MA, as compared to traditional teaching methods that are currently used to teach students at the MA. Scientific research methodology was used to determine the validity of the tests used within the study (see par 4.3). The aim of the theoretical background was to indicate the current stand of technology within education, the different theories learning used to teach students, and how GBL is currently used within education. The empirical aim was to reflect the experimental results statistically.

The contribution of this study is rooted in the different outputs produced by the research. The study demonstrated that GBL had a significant influence on the learning gains of CIS students (see Table 4.2), and that traditional teaching methods used also had a significant positive influence on the learning gains (see Table 4.3) of CIS students at the MA. The study proved that within the MA educational environment GBL can be used effectively to teach undergraduate students. It can thus be concluded that GBL can be exploited as a teaching pedagogy within the MA, given that, as deduced from this study, the GBL environment used is beneficial to the student and can considerably improve the knowledge of the student with regards to the subject matter. In addition, the findings indicate that GBL can be effective in the teaching of JavaScript to undergraduate students.

The results indicated that within the parameters of the research experiment, there were no significant differences in the results obtained from the GBL group and the traditional teaching group. Indicating that the learning gain scores from participants in the GBL group were not significantly better than the participants in the traditional teaching group. This result indicates that GBL may not necessarily lead to better student results at the MA.

The specific game employed in this study was relatively simple and designed to be used by any age, gender, or academic background. Players need not have prior knowledge of computer programming to be able to play the game and understand what the code means. It has sophisticated storylines, sound effects, and a user interface that is designed to immerse the player. The game itself is quite simple and lack the sophistication of commercial games that students play in their free time. However, this perhaps help to substantiate the findings. Given that the game had a positive effect on the learning gains of students that played it during the study.

5.6. Limitations

Recognition of the limitations of this study is important because it qualifies and tempers the findings. The limitations also provide future researchers with recommendations to further the research conducted. Limitations of the research study became apparent when conducting the study and the results of the study should be viewed with the following limitations in mind:

- The study participants represent a subset of the student population at the MA which is a subset of the military population of the SANDF. A replication of the study with a wider study grouping in terms of area of study, and academic setting would enhance the generalisability of the findings of this study.
- This study was conducted with participants within the junior officer ranks (Candidate Officer to Captain for SAA, SAAF, and SAMHS. Midshipman to Lieutenant for SAN), because more than 90% of the students at the MA are junior officers.
- All participants had to be residential students of the MA, and had to be enrolled for one of the CIS modules. This ensured that all participants had basic computer literacy and could participate without having a computer skills knowledge barrier.
- One issue that needs to be considered to ensure the validity of the research design: for 57% of the participants had no previous JavaScript experience or knowledge and coding

within the experiment was their first experience with JavaScript. This contributed to the learning gains being very high in some cases.

- JavaScript was the only scripting language taught during the experiment and participants were only evaluated on their knowledge thereof, no other programming language or skill was tested.
- The relatively small sample size in this study limits the generalisability of the results to the larger university population. The size of the data set used also limits the use of various statistical analyses. A larger number of participants could have contributed more confidence in the results of the study.
- A methodological weakness of the study is that only 15% of the participants were females. A better gender representation could be considered with a larger female participant grouping. For this reason, no gender specific results were obtained during the study.
- The research experiment was conducted within less than a semester. A longitudinal study could possibly provide a better insight into the implementation of GBL and the impacts thereof on student results.

Although the study revealed some limitations, the research still provided new information to the literature on Learning, Gaming, and GBL. The study contributes to the research on GBL within higher education and specifically the MA in support of the limited amount of literature available within the SANDF.

5.7. Recommendations

Recommendations for future research and how the results of this study could be used for different teaching pedagogies are discussed. Recommendations are based on the results of the study as well as the experience of designing and implementing the research experiment (intervention) that was the central focus of the study. Future research on applying GBL within

the educational environments of the SANDF might aid in the development of a better teaching curriculum, or teaching approaches. Research aimed at educational technology with specific focus on games, GBL, or similar teaching methods could lead to the development of a wider variety of educator skills within the SANDF and higher education. This could lead to the implementation of more interactive and engaging teaching methods that may lead to better student understanding and implementation of knowledge gained through education.

All participants were residential students of the MA, and were adult learners studying towards a bachelor's degree. The research experiment might be repeated on a secondary educational level and results of that experiment can be used to investigate whether GBL could be used as a teaching method on a secondary educational level. Enriched literature and research could also be gained from gathering data from other faculties of the Stellenbosch University except for the MA, as other faculties have a different work ethic and teaching philosophy than the Faculty of Military Sciences.

An expansion of this research might include a different learning pedagogy other than GBL that might be of interest to other educators or stakeholders at the MA or within the SANDF. The examination of other variables of interest to educators at the MA could include specific demographic characteristics such as corps mustering, arms of service, age, or rank. This will enable better and more refined statistical analysis and will enable future researchers to define the differences between corps and arms of services better within the MA setting. A bigger sample of students will enable a better understanding of skills between age groupings and contribute to better statistical analysis which can indicate to an educator what generation of students might benefit from GBL.

Although there was no significant difference between GBL and traditional teaching within the research experiment parameters, the relationship between the two pedagogies should be explored in more detail to investigate whether GBL can efficiently be used in conjunction

with traditional teaching methods. Furthermore, GBL should be tested in a different educational environment within the SANDF or higher educational institutes to better understand if GBL can be implemented as a teaching method. Further research efforts such as these might enable the MA and SANDF to do research with the intent of implementing different teaching pedagogies within the SANDF especially at the MA. This may lead to a more cohesive teaching model that can be used to adapt to new teaching methods.

Optimistically this study should provide an interest for future research into the use of GBL as a teaching method, leading into a detailed investigation into where and how GBL can be used within the MA. Testing GBL within an academic module at the MA might prove advantageous for the retaining of knowledge. Future research should test GBL against other teaching pedagogies within the MA to test for a best fit for use within this environment.

Only one game was used within the study, which leaves room for future research to study which kind of game best fits within the MA and what sort of curriculum can accommodate such a game. It would be interesting to use different games at the same time and compare the results of the different studies. Furthermore, future research into GBL could perhaps use a sample of participants who are actively involved in education other than academic or higher education within the wider SANDF and within training units. This type of research could give insight into the use of GBL for training soldiers in a variety of weapons and equipment. A good motivation for this kind of research is the current budget cuts that face an already struggling SANDF. Further research is needed within the SANDF to explore if GBL can be used successfully and to explore the complexity of reality and gameplay. Training units could design a curriculum for different training situations wherein GBL could fit within what the organisation deems as its standard of training.

It is recommended that this study be expanded and incorporate a larger sample of students from different study areas within the MA ensuring a better analysis of GBL within the MA.

Although Code Combat was a good fit for the research experiment it is recommended that a game be well tested to ensure it incorporates not only scripting languages but other coding languages such as C#, Visual Basic, Java, etc. to ensure a larger sample of interested participants.

It is also recommended that whenever GBL is implemented within the educational environment, students that are already computer literate are used. Students from rural areas often experience techno phobia when starting tertiary studies, and this may lead to a detriment of the student's interest and ability to perform well within a subject. Within the MA it is recommended that GBL be used with students that are second or third year students, because they will already have passed the first year CIS modules ensuring basic computer literacy. Computer literate students will be more enthusiastic to learn new skills and will be less reluctant to partake in education such as GBL.

Using the correct teaching pedagogy for the right audience or generation of students will positively influence the students' mind-set toward studying and doing well. This will benefit the MA in achieving its goals of educating young officers and contribute to the goals of having a well-educated military.

References

- Alexander, A. L., Brunye, T., Sidman, J., & Weil, S. A. (2005). From Gaming to Training: A review of studies on fidelity, Immersion, Presence, and Buy-in and their effects on transfer in PC-based simulations and games. *Aptima, inc*, 1-14.
- Annetta, L. A. (2008). Video Games in Education: why they should be used and how they are beign used. *Theory not Practice*, 47(3), 229-239.
- Ballance, C. (2013). Use of games in training: interactive experiences that engage us to learn. *Industrial and Commercial Training*, 45(4), 218-221. doi:10.1108/00197851311323501
- Bornman, E. (2016). Information Society and digital divide in South Africa: results of longitudinal surveys. *Information, Communication and Society*, 19(2), 264-278.
- Borokhovski, E., Bernard, R. M., Tamim, R. M., Schmid, R. F., & Sokolovskaya, A. (2016). Technology-supported student interaction in post-secondary. *Computers and Education*, 96, 15-28.
- Boumova, V. (2008). *Traditional vs. Modern Teaching Methods: Advantages and Disadvantages of each*. Masaryk University Faculty of Arts, Department of English and American Studies. Masryk University. Retrieved October 29, 2016, from https://is.muni.cz/th/86952/ff_m_b1/MgrDiplomkaBoumova.pdf
- Bozalek, V., & Matthews, L. (2009, March). E-Learning A cross institutional forum for sharing socio-cultutral influences on personal and professional identity. *International Social Work*, 52(2), 235-246.
- Buckley, K. E., & Anderson, C. A. (2006). A Theoretical model of the effects and consequences of playing video games. In P. Vorderer, & J. Bryant, *Playing Video*

Games- Motives, Responses, and Consequences (pp. 363-378). Mahwah, New Jersey, United States of America.

Burgess, S. R., Stermer, S. P., & Burgess, M. C. (2012). Video Game Playing and Academic Performance in College Students. *College Student Journal*, 367-387.

Cant, M., & Bothma, C. (2010). The learning-technology conundrum: Lecturer's perspectives. *Progressio*, 32(1), 55-73.

Carini, R. M., Kuh, G. D., & Klein, S. P. (2006, February). Student Engagement and Student Learning: Testing the Linkages. *Research in Higher Education*, 47(1), 1-32.

Cherry, K. (2016, April 16). *Psychology, Operant Conditioning*. Retrieved from Verywell: <https://www.verywell.com/operant-conditioning-a2-2794863>

Chimbwanda, D., Dodd, N., Naik, P., & Tebele, C. (2010). *HRD in South Africa: A Primer*. Excel Learning.

Chmiel, M. (2015). *Game Based Learning*. Retrieved July 7, 2016, from Research Starters: Education (Online Edition): <http://eds.a.ebscohost.com.nwulib.nwu.ac.za/eds/>

Connolly, M., Jones, N., & Turner, D. (2006). E-learning A fresh Look. *Higher education management and policy*, 18(3), 1-12.

Creswell, J. W. (2014). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Thousand Oaks, California, United States of America: SAGE Publications Inc.

De Houwer, J., Barnes-Homes, D., & Moors, A. (2013, January 29). What is Learning? On the nature and merits of a functional definition of learning. *Psychonomic Society, Inc.*, 20, 631-342.

- Dickey, M. D. (2011). Murder on Grimm Isle: The impact of game narrative design in an educational game-based learning environment. *British Journal of Educational Technology*, 42(3), 456-469.
- EdTechReview. (2015, August 25). *What is Game Based Learning?* Retrieved from EdTechReview: <http://edtechreview.in/dictionary/298-what-is-game-based-learning>
- e-learningNC. (2016, September 22). *What is e-learning?* Retrieved from e-learningNC: http://www.e-learningnc.gov/about_e-learning/what_is_e-learning/
- Ettinger, A., Holton, V., & Blass, E. (2006). E-Learner experiences: What is the future of e-learning? *Industrial and Commercial Training*, 38(4), 208-212. Retrieved April 30, 2015
- Festl, R., Scharkow, M., & Quandt, T. (2013). Militaristic Attitudes and the Use of Digital Games. *Games and Culture*, 8(6), 392-407.
- Fitzgerald, H. E., Bruns, K., Sonka, S. T., Furco, A., & Swanson, L. (2012). The Centrality of Engagement. *Journal of Higher Education Outreach and Engagement*, 16(3), 7-27.
- Flavin, M. (2016). Disruptive conduct: the impact of disruptive technologies on social. *Innovations in Education and Teaching International*, 53(1), 3-15. doi:10.1080/14703297.2013.866330
- Garris, R., Ahlers, R., & Driskell, J. E. (2002, December 1). Games, Motivation, and Learning: A Research and Practice Model. *Simulation Gaming*, 33, 441-467.
- Gee, J. P. (2003). *What Video Games have to teach us about learning and literacy*. New York, New York, USA: Palgrave Macmillan.
- Gee, J. P. (2009). Deep Learning Properties of good video games: how far can they go? *Serious games: Mechanisms and effects*, 67-82.

- Gee, J. P. (2011). Reflections on empirical evidence on games and learning. In S. Tobias, & J. D. Fletcher, *Computer Games and Instruction* (pp. 223-232). Charlotte, North Carolina: Information Age Publishing.
- Gee, J. P. (2015). Partnership for 21st century skills. *Blogazine*, p. 21. Retrieved from Appeared in P21 Blogazine. (Partnership for 21st Century Skills), 2015
- Gee, J. P., & Williamson Schaffer, D. (2010). Looking where the light is bad: video games and the future of assessment. *Phi Delta Kappa International*, 6(1), 2-19. Retrieved August 05, 2015, from Partnership for 21st century skills.
- Goldstein, I. L., & Ford, J. K. (2002). *Training in Organisations* (Vol. 4). Canada: Wadsworth.
- Granic, I., Lobel, A., & Engels, R. C. (2014). The Benefits of Playing Video Games. *American Psychologist*, 69(1), 66-78. doi: 10.1037/a0034857
- Gravetter, F. J., & Forzano, L.-A. B. (2012). *Research Methods for the Behavioral Sciences*. Belmont: Cengage Learning.
- Grow, G. (1991). Teaching Learners to be Self-Directed: A Stage Approach. *Adult Education Quarterly*, 41(3), 125-149.
- Grundlingh, A. (2013). *Leader Success In The Military: A Challenge For The Twenty First Century* (Vol. 1). Western Cape, South Africa: Scholar's Press.
- Gumulak, S., & Webber, S. (2011). Playing video games: learning and information literacy. *Aslib proceedings: New information Perspectives*, 63(2), 241-255.
- Henderson, L. (2005). Video Games: A Significant Cognitive Artifact of Contemporary Youth Culture. *Changing Views- Worlds at Play* (pp. 1-15). Townsville: Digital Game Research Association DiGRA.

- Herselman, M. E., & Hay, H. R. (2005). An investigation into e learning practices: Implications for providers of education and training. *Unissa Press, 19*(2), 393-410.
- Hilton, R. (2006). Gaming as an educational tool. *Young Consumers, 1*, 14-19.
- Howarth, K. (1999). What makes Games an Educational Tool?: Building Thinking Skills and Responsibilities into the Games Program. *A Journal for Physical and Sport Educators, 13*(1), 29-32.
- Jayakanthan, R. (2002). Application of computer games in the field of education. *The Electronic Library, 20*(2), 98-102.
- Johnson, L., Smith, R., Willis, H., Levine, A., & Haywood, K. (2011). *The Horizon Report*. Austin, Texas: New Media Consortium. Retrieved October 29, 2016, from <http://net.educause.edu/ir/library/pdf/HR2011.pdf>
- Kebritchi, M. (2010). Factors effecting teachers' adoption of educational computer games: A case study. *British Journal of Educaiton Technology, 40*(2), 256-270.
- Kirkpatrick, D. (1996, January). Great Ideas Revisited. *Training and Development, 54-59*.
- Kleber, J. (2015, January/February). Differentiation through blended learning. *Leadership, 20-24*.
- Knight, S. (2009, 4 12). *Effective pratice in a digital age: A guide to technology-enhanced learning and teaching*. Bristol: JISC. Retrieved from Joint Inforamtion Systems Comittee report.
- Knowles, M. (1980). *The Modern Practice of Adult Education: from Pedagogy to Andragogy* (Vol. 3). Chigago: Association Press.
- Krotoski, A. (2010). Serious fun with computer games. *Nature, 466*(5), 695.

- Kuhn, S., Gleich, T., Lorenz, R. C., & Gallinat, J. (2014). Playing Super Mario induces structural brain plasticity: gray matter changes from training with a commercial video game. *Molecular Psychiatry*, *19*, 265-271. doi:10.1038/mp.2013.120
- Kumar, R. (2011). *Research Methodology: A Step-by-Step Guide for Beginners 3rd edition*. London, England: SAGE Publications Ltd.
- Marshall, S. (2016). Technological innovation of higher education in. *Studies in Higher Education*, *41*(2), 288-301. doi:10.1080/03075079.2014.927849
- McClarty, K. L., Orr, A., Frey, P. M., Dolan, R. P., Vissileva, V., & McVay, A. (2012). *A Literature Review of Gaming in Education*. Pearson. Retrieved October 26, 2016
- McFarlane, A., Sparrowhawk, A., & Heals, Y. (2002). Report on the educational use of games. *TEEM, for the Department of Education and Skills*.
- McGrath, C. H., Guerin, B., Harte, E., Frearson, M., & Manville, C. (2015). *Learning gain in higher education*. Santa Monica, California, United States of America: RAND Corporation. Retrieved October 2, 2016, from http://www.rand.org/pubs/research_reports/RR996.html.
- McLeod, S. (2013). *Pavlov's Dogs*. Retrieved from Simply Psychology: www.simplypsychology.org/pavlov.html
- Meijer, S. A., & Smeds, R. (2014). Achieving game goals at all costs? – the effect of reward structures on tactics employed in educational military wargaming. *Frontiers in Gaming Simulation*, *8264*, 13-20.
- Mendenhall, W., Beaver, R. J., & Beaver, B. M. (2013). *Intorduction to Probability and Statistics, Fourteenth Edition*. (M. Juliet, Ed.) Brooks/Cole, Boston, United States of America: Cengage.

- Mouton, J. (2005). *How to succeed in your Masters and Doctoral studies: SA Guide and Research Book* (4 ed.). Pretoria: Van Schaik Publishers.
- Nauert, R. (2013, November 26). *Video Games Can Help Boost Social, Memory and Cognitive Skills*. Retrieved December 3, 2013, from PsychCentral: <http://psychcentral.com/news/2013/11/26/video-games-help-boost-social-memory-cognitive-skills/62537.html>
- O'Byrne, W. I., & Kristine, E. P. (2015, September/October). Hybrid and Blended Learning: Modifying Pedagogy Across Path, Pace, Time and Place. *Journal of Adolescent and Adult Literacy*, 59(2), 137-140. doi:10.1002/jaal.463
- Oxford University Press. (2014, September 15). *Oxford Dictionaries Language Matters*. Retrieved from Oxford Dictionaries Language Matters: <http://www.oxforddictionaries.com/definition/english/video-game>
- Palfrey, J., & Gasser, U. (2008). *Born Digital: Understanding the First Generation of Digital Natives*. New York: Basic Books.
- Paraskeva, F., Mysirlaki, S., & Papagianni, A. (2010). Multiplayer online games as educational tools: Facing new challenges in learning. *Computers and Education*, 54, 498-505.
- Porter, S. R. (2006, August). Institutional Structures and Student Engagement. *Research in Higher Education*, 47(5), 521-558. Retrieved June 09, 2016
- Prensky, M. (2001). True Believers: Digital Game-Based Learning in the Military. In M. Prensky, *Digital Game-Based Learning* (pp. 1-18). McGraw-Hill.
- Qian, M., & Clark, K. R. (2016, May 8). Game-based Learning and 21st century skills: A review of recent. *Computers in Human Behavior*, 63, 50-58.

- Reynolds, C. R., & Fletcher-Janzen, E. (2007). *Encyclopedia of Special Education, Third edition* (Vol. 3). Hoboken, New Jersey, United States of America: John Wiley & Sons Incorporated.
- Ricci, K. E., Salas, E., & Cannon-Bowers, J. A. (2002). Do Computer-Based Games Facilitate Knowledge Acquisition and Retention? *Military Psychology, 8*(4), 295-307.
- Scarborough, W. (2013). *A Collection of Chinese Proverbs Translated and Arranged*. London, England: Forgotten Books.
- Schwerdt, G., & Wupperman, A. C. (2011). Is traditional teaching really all that bad? A within-student. *Economics of Education Review, 30*, 365-379.
- Setzer, C. J., & He, Y. (2009). Reliability Analysis for the Internationally Administered 2002 Series GED Tests. *GED Testing Service: Research Studies, 3*.
- Shergill, H. K. (2010). *Psychology part 1* (1 ed.). PHI Learning Pvt. Ltd.
- Simmons, L. K. (2007). The Grand Experiment: Modeling Adult Learning with Adult-Ministry Students. *Teaching Theology and Religion, 10*(1), 42-49. Retrieved May 29, 2016
- Singh, A. (2004). Bridging the digital divide: the role of universities in getting South Africa closer to the global information society. *South African Journal of Information Management, 6*(2). doi:10.4102/sajim.v6i2.388
- Stellenbosch University. (2013). *Faculty of Military Science Calender*. Stellenbosch: Stellenbosch University.
- Stellenbosch University. (2013). *Faculty of Military Science Calender 2011*. Stellenbosch: Stellenbosch University.

- Tappeiner, E., & Lyons, C. (2008). Selection criteria for academic video game collections. *Collection Building*, 27(3), 121-125.
- Vos, L., & Brennan, R. (2010). Marketing simulation games: student and lecturer perspectives. *Marketing Intellegence and Planning*, 28(7), 882-897.
- Weiss. (2002). In I. Goldstein, & J. Ford, *Training in Organisations* (Vol. 4, p. 172). Wadsworth, Canada.
- Williams, T. A., Sweeney, D. J., & Anderson, D. R. (2012). *Contemporary Business Statistics Fourth Edition*. Canada: South-Western Cengage Learning.