

**A MODEL FOR SELECTING SERIOUS GAMES FOR THE  
COMPUTER SCIENCE CLASS**

**Johan Willem Prinsloo**  
**Student number: 12302341**

Dissertation submitted in fulfilment of the requirements for the degree

**MAGISTER SCIENTIAE IN COMPUTER SCIENCE**

in the discipline of

**Computer Science**

in the

**FACULTY OF ECONOMIC SCIENCES AND INFORMATION  
TECHNOLOGY**

at the

**NORTH-WEST UNIVERSITY  
VAAL TRIANGLE CAMPUS**

**Supervisor: Prof DB Jordaan**  
**2014**



## **ACKNOWLEDGEMENTS**

I would like to thank my supervisor Prof. Dawid Jordaan for all his patience, advice and guidance throughout the exploration and learning process of this thesis. I would further like to thank all the participants who have devoted their time and energy in this study to evaluate the various models and complete the questionnaires. Lastly I would like to thank my family for their love and support throughout the duration of this study.

## **ABSTRACT**

Serious games have the potential to add value to the teaching and learning environment but are currently not used to its full potential in the Computer Science class. Many reasons why serious games are not used are debated in the literature and a particular problem identified from the literature is that educators find it difficult to select appropriate serious games for use in the classroom environment.

The research philosophy adopted for this study included the Critical Social Theory paradigm and action research as the research method. The five phases of the action research process, namely diagnosing, action planning, action taking, evaluating and specifying learning were used to provide educators with a useful model to help with the selection of serious games for the Computer Science class.

During the diagnosing phase, the problem for this study was identified and a questionnaire was used to determine educators' perceptions of serious games that confirmed the problem identified during the literature survey.

During the action planning phase the evaluation of three serious game selection models, namely the four-dimensional framework, the RETAIN model and the Magic Bullet model were planned. Participants were provided with a checklist in the form of tables so that they could familiarise themselves with the models.

During the action taking phase participants evaluated the four-dimensional framework, the RETAIN model and the Magic Bullet model using the checklists and examples provided to them.

During the evaluation phase the three different models were evaluated by the participants and a questionnaire was used to gather data. The data were analysed and results were reported. A major problem was identified and it was decided to initiate a second cycle of the action research process. This time participants were provided with serious games and in a joint effort of the participants the problem was addressed.

During the second cycle the problems identified in the first cycle was resolved.

Finally this study is concluded with a reflection on all the research questions identified, a report on the findings, recommendations and a discussion of the limitations of the research project.

**Keywords:** RETAIN model, four-dimensional framework, Magic Bullet model, action research, serious games

## UITTREKSEL

'Serious games' het die potensiaal om waarde toe te voeg tot die onderrig en leer omgewing maar dit word tans nie tot sy volle potensiaal in die rekenaar wetenskap klas gebruik nie. Baie redes hoekom 'serious games' nie gebruik word nie word in die literatuur gedebatteer. 'n Spesifieke probleem, naamlik dat dosente die moeilik vind om 'n geskikte 'serious games' vir gebruik in die klaskamer omgewing te selekteer, is in die literatuur geïdentifiseer.

Die navorsings filosofie wat gebruik is vir hierdie studie is, die kritiese sosiale teorie paradigma en aksienavorsing is as navorsing metode gebruik. Die vyf fases van die aksie navorsing proses, genaamd, diagnose, aksie-beplanning, aksie neem, evaluering en spesifisering van leer is gebruik om dosente te voorsien met 'n bruikbare model om 'serious games' te selekteer vir die rekenaar wetenskap klas.

Gedurende die diagnose-fase is die probleem vir hierdie studie geïdentifiseer en 'n vraelys is gebruik om 'n profiel op te stel van die dosente se persepsies van 'serious games'. Hierdie persepsies het die probleem wat in die literatuur geïdentifiseer is bevestig.

Gedurende die aksie beplannings-fase is die evaluasie van die drie 'serious games' seleksie modelle, genaamd die Vier Dimensionele raamwerk, die RETAIN model en die Magic Bullet model beplan. Deelnemers is met 'n kontrole lys toegerus in die vorm van tabelle sodat hulle hulself kon vergewis van die modelle.

Gedurende die aksie neem fase het deelnemers die Vier Dimensionele raamwerk, die RETAIN model en die Magic Bullet model geëvalueer deur gebruik te maak van die kontrole lys en voorbeelde wat aan hulle voorsien is.

In die evaluering-fase is die drie verskillende modelle geëvalueer deur die deelnemers en 'n vraelys is gebruik om data te versamel. Die data is geanaliseer en die resultate is gerapporteer. 'n Groot probleem is geïdentifiseer en daar is besluit om 'n tweede siklus van die aksie navorsings proses te inisieer. Die keer is

deelnemers toegerus met twee 'serious games' en in 'n gesamentlike poging het deelnemers die probleem aangespreek.

Gedurende die tweede fase is die probleme van die eerste fase opgelos.

Laastens is die studie afgesluit deur te reflekteer op al navorsing vrae wat aanvanklik geïdentifiseer is, die bevindinge te rapporteer, aanbevelings te maak en tekortkominge te rapporteer.

**Sleutelwoorde:** RETAIN model, Vier Dimensionele raamwerk, Magic Bullet model, aksienavorsing, serious games.

# Table of Contents

Acknowledgements.....	ii
Abstract.....	iii
Uittreksel.....	v
<b>1. CHAPTER ONE: ORIENTATION .....</b>	<b>1</b>
1.1. Introduction .....	1
1.2. Defining serious games .....	2
1.3. Serious games in education .....	3
1.4. Problem statement .....	4
1.5. Research objectives.....	5
1.6. Research questions .....	5
1.7. Research methodology.....	5
1.8. Research execution .....	7
1.9. Target population, sample frame, sample method and sample size .....	8
1.9.1. Target population .....	8
1.9.2. Sample frame.....	8
1.9.3. Sample method .....	9
1.9.4. Sample size.....	9
1.10. Ethical considerations .....	9
1.11. Layout of the study .....	9
1.12. Conclusion.....	10
<b>2. CHAPTER TWO: LITERATURE STUDY.....</b>	<b>11</b>

<b>2.1.</b>	<b>Introduction .....</b>	<b>11</b>
<b>2.2.</b>	<b>Background .....</b>	<b>11</b>
<b>2.3.</b>	<b>Serious games.....</b>	<b>12</b>
<b>2.4.</b>	<b>Taking advantage of game characteristics for learning .....</b>	<b>14</b>
<b>2.5.</b>	<b>Challenges in embedding serious games into formal education.....</b>	<b>16</b>
<b>2.6.</b>	<b>Models and frameworks to evaluate serious games.....</b>	<b>18</b>
2.6.1.	The RETAIN model .....	19
2.6.2.	The four-dimensional framework .....	24
2.6.3.	The Levee Patroller project .....	28
2.6.4.	The Magic Bullet model.....	32
<b>2.7.</b>	<b>Discussion of the models and the framework.....</b>	<b>37</b>
2.7.1.	Similarities and differences.....	39
<b>2.8.</b>	<b>Conclusion.....</b>	<b>40</b>
<b>3.</b>	<b>CHAPTER THREE: RESEARCH METHODOLOGIES.....</b>	<b>42</b>
<b>3.1.</b>	<b>Introduction .....</b>	<b>42</b>
<b>3.2.</b>	<b>Background .....</b>	<b>42</b>
<b>3.3.</b>	<b>Research paradigms .....</b>	<b>44</b>
3.3.1.	Positivism.....	47
3.3.2.	Interpretivism.....	49
3.3.3.	Critical social research .....	50
<b>3.4.</b>	<b>Research methods .....</b>	<b>51</b>
3.4.1.	Action research .....	51
<b>3.5.</b>	<b>Data collection techniques .....</b>	<b>57</b>

3.5.1.	Observation.....	57
3.5.2.	Interviews.....	58
3.5.3.	Questionnaires.....	58
3.5.4.	Mixed methods.....	59
<b>3.6.</b>	<b>Quality criteria for research.....</b>	<b>66</b>
<b>3.7.</b>	<b>Research validation.....</b>	<b>69</b>
<b>3.8.</b>	<b>Ethical consideration.....</b>	<b>70</b>
<b>3.9.</b>	<b>Conclusion.....</b>	<b>70</b>
<b>4.</b>	<b>CHAPTER FOUR: THE RESEARCH STRATEGY AND</b>	
<b>ANALYSIS</b>	<b>.....</b>	<b>71</b>
<b>4.1.</b>	<b>Introduction.....</b>	<b>71</b>
<b>4.2.</b>	<b>Research strategy.....</b>	<b>71</b>
4.2.1.	Research environment.....	72
<b>4.3.</b>	<b>Action research: first cycle.....</b>	<b>73</b>
4.3.1.	Diagnosing: first cycle.....	73
4.3.2.	Action planning: first cycle.....	75
4.3.3.	Action taking: first cycle.....	85
4.3.4.	Evaluating: first cycle.....	85
<b>4.4.</b>	<b>Action research: second cycle.....</b>	<b>88</b>
4.4.1.	Diagnosing: second cycle.....	88
4.4.2.	Action planning: second cycle.....	88
4.4.3.	Action taking: second cycle.....	90
4.4.4.	Evaluating: second cycle.....	96

4.5.	<b>Specifying learning .....</b>	<b>98</b>
4.6.	<b>Conclusion.....</b>	<b>99</b>
5.	<b>CHAPTER FIVE: CONCLUSIONS, RECOMMENDATIONS AND FUTURE RESEARCH.....</b>	<b>100</b>
5.1.	<b>Introduction .....</b>	<b>100</b>
5.2.	<b>Research conclusions .....</b>	<b>100</b>
5.2.1.	First research question.....	101
5.2.2.	Second research question.....	101
5.2.3.	Third research question.....	101
5.3.	<b>Research findings .....</b>	<b>104</b>
5.3.1.	First finding.....	105
5.3.2.	Second finding .....	105
5.4.	<b>Recommendations .....</b>	<b>105</b>
5.5.	<b>Research limitations .....</b>	<b>105</b>
5.6.	<b>Future research opportunities.....</b>	<b>106</b>
5.7.	<b>Contributions to the body of information .....</b>	<b>106</b>
5.8.	<b>Conclusion.....</b>	<b>107</b>

## List of Tables

Table 1: The RETAIN rubric .....	20
Table 2: The RETAIN weighting chart .....	23
Table 3: Checklist for evaluating the use of educational games and simulations .....	27
Table 4: Area and attributes of a serious game .....	30
Table 5: Summary of Soft vs Hard Research Dichotomies (Contrasts).....	45
Table 6: Information systems action research forms and characteristics .....	53
Table 7: Two typologies of reasons for mixing methods .....	60
Table 8: Checklist for the four-dimensional framework .....	77
Table 9: Outcome of the evaluation of MediaStage using the four-dimensional framework .....	78
Table 10: Checklist for the RETAIN model .....	79
Table 11: Outcome of the evaluation of Math Blaster using the RETAIN framework .....	82
Table 12: Checklist for the Magic Bullet model.....	83
Table 13: Completed RETAIN framework for ColoBot.....	91
Table 14: Scoring table for ColoBot.....	91
Table 15: Completed four-dimensional framework for Colobot .....	92
Table 16: Completed RETAIN framework for Light-Bot 2 .....	94
Table 17: RETAIN scores for ColoBot.....	94
Table 18: Completed four-dimensional framework for Light-Bot 2 .....	95
Table 19: Summary of evaluation of the models and framework – first cycle.....	102
Table 20: Summary of evaluation of the models and framework – second cycle .....	103

## List of Figures

Figure 1: Research methodology .....	6
Figure 2: A framework for evaluating game-based and simulation-based education .....	26
Figure 3: The Magic Bullet colour code .....	34
Figure 4: The Magic Bullet (good balance).....	34
Figure 5: The Magic Bullet (MUST learn = CAN learn).....	35
Figure 6: The Magic Bullet (MUST learn ~ CAN learn).....	36
Figure 7: The Magic Bullet (MUST learn > CAN learn).....	36
Figure 8 The Magic Bullet (MUST learn – includes collateral learning).....	37
Figure 9: Summary of three research paradigms .....	47
Figure 10: Phases within an action research cycle.....	56
Figure 11 : Six major mixed methods research design .....	65
Figure 12: A well-balanced Magic Bullet.....	84
Figure 13: Screenshot of ColoBot .....	89
Figure 14: Screenshot of Light-Bot 2.....	90
Figure 15: Magic Bullet representing Colobot.....	93
Figure 16: Magic Bullet representing Light Bot 2 .....	96

# CHAPTER ONE: ORIENTATION

## 1.1. Introduction

The purpose of this study is to recommend a suitable model for the selection of serious games for the Computer Science class. Serious games are digital games with an educational intention of teaching specific predefined skills and knowledge (Ulicsak & Wright, 2010:27). Wrzesien and Alcañiz Raya (2010:179) indicated that serious games provide a powerful and effective learning environment. However, according to Kadle (2009:5) many schools and universities that consider adopting digital game-based learning do not know where to start. The sheer variety and depth of the digital game-based learning makes it difficult for educators to decide on an appropriate strategy or approach.

Computer games form an integral part of the lives of many children and young people (Lenhart & Kahne, 2008:2) and these games regularly attract and keep their attention for long periods of time (Robertson, 2012:1). Based on research done there is an increase in interest shown among learners in the use of serious games and simulations to support curricular outcomes (De Freitas & Olivier, 2006:250). It is not surprising that teaching and learning environments, for example classrooms, health care, corporate and military training, integrate computer games more and more often into their learning and training programmes (Guillén-Nieto & Aleson-Carbonell, 2012:436). According to Garris *et al.* (2002:441-442) there are three major factors, that may have played an important role in the rapid growth of serious games in education and professional training namely a paradigm shift in the field of teaching and learning, the introduction of new interactive technologies that allow students to actively engage in problem-solving and the enormous ability of serious games to immerse and engage students in academic content (Garris *et al.*, 2002:441-442). The first factor, the appearance of a new teaching and learning concept has brought forth three significant changes (Guillén-Nieto & Aleson-Carbonell, 2012:436): (a) a shift from an educator-centred to a learner-centred approach, (b) a model of interaction and instruction based on doing has replaced the model of instruction, based on listening and (c) a shift to a concept of learning, based

on the capacity to find and use information instead of a concept of learning, based on memory. This view is supported by Denner *et al.* (2010:241) when they argued that students should identify with knowledge and make it their own, engage with other students and believe that understanding is much more important than memorising procedures and rules.

In their research Wrzesien and Alcañiz Raya (2010:179) also indicated that serious games provide a powerful and effective teaching and learning environment. Guillén-Nieto and Aleson-Carbonell (2012:436) have studied the literature on serious games over the last decade and came to the conclusion that the literature emphasised three main reasons why the use of serious games in education has increased: (a) serious games use actions rather than explanations and create personal motivation and satisfaction, (b) serious games accommodate various learning styles and abilities and (c) encourage decision-making and problem-solving activities in a virtual setting. Mayo (2007:32) has identified some potential advantages of serious games in education: massive reach, experimental learning, self-efficacy, enquiry-based learning, goal-setting, enhanced brain chemistry, continuous feedback and time-on-task.

It is evident from this brief exploration that many research studies and results indicate that serious games have the potential to add value to teaching and learning. The next section briefly explores some definitions of serious games followed by more discussions and definitions in the literature review in Chapter 2.

## **1.2. Defining serious games**

It is evident from the literature that there are many definitions of serious games and many ways to classify serious games and their relationship to virtual worlds and simulations. Sawyer and Smith (2008:10) regard these definitions as different categories of the same thing. Most definitions of serious games agree more or less, that serious games are concerned with the use of games and game technology for purposes other than entertainment. These purposes include education, training and health. Serious games are games with an educational intent and need to be

engaging while learning can be implicit or explicit (Ulricsak & Wright, 2010:27). From the many definitions of serious games (Wouters *et al.*, 2009:2; Micheal & Chen, 2006:21; Vogel *et al.*, 2006:231; Garris *et al.*, 2002:443) one can conclude that a serious game is goal-directed, has a competitive activity and is conducted within a framework of agreed rules (Lindley, 2004). Furthermore, serious games enable players to monitor their progress towards the goal and provide constant feedback (Prensky, 2001:118-124). This definition of serious games will be adopted for the purpose of this study.

It is features like competitive activities, goal-directedness, a framework of agreed upon rules, progress towards a goal and constant feedback that can contribute to make serious games a useful tool in education.

### **1.3. Serious games in education**

In the last few years the academic research community has paid significant attention to the ways in which serious games support learning. The value of serious games in education according to Rieber, Smith and Noah (1998:3) is undeniable and the potential benefits of using serious games as ideal classroom instruction companions are unquestionable (Guillén-Nieto & Aleson-Carbonell, 2012:436; Wrzesien & Alcañiz Raya, 2010:178).

Gee and Shaffer (2010:1) argue that games teach 21<sup>st</sup> century skills like problem-solving, collaboration and negotiation. Current educational systems are not accessing these skills that games, in particular epistemic games that model professional practice, could teach and assess. Good commercial games build on previous information, require problem-solving, critical thinking and provide appropriate challenges (Gee & Shaffer, 2010:1).

It is a complex task to identify games that can be used for education (Ulricsak & Wright, 2010:5). There is no uniform pedagogy (methods and principles of teaching) within serious games. Some of the earlier games used the behaviourist model, while newer games use the experiential model, situated within socio-cultural pedagogical

models. The learning outcomes and how they are achieved are influenced by the pedagogy used, game mechanics and the integration of content in the game (Ulicsak & Wright, 2010:5).

#### **1.4. Problem statement**

Many research reports argue that digital games, including simulations and virtual worlds, have the potential to be significant teaching tools because of their interactive, engaging and immersive activities (Ulicsak & Wright, 2010:14-16; Gee, 2008:27; Smith, 2007:18-19; Shaffer *et al.*, 2005:4). Despite the rapid growth of the games industry over the past decades, the use of games in education are still limited (Westera *et al.*, 2008:420). Harteveld and Bidarra (2007:555) defined the post-industrial way of learning and thinking as the *traditional paradigm* and the interactive, entertaining and authentic way of learning and thinking as the *gaming paradigm*. Shaffer *et al.* (2005:16) stated that it is unclear how this *gaming paradigm* should be implemented to create an effective teaching and learning experience. De Freitas and Oliver (2006:251) found that when educators are thinking of introducing games- and simulation-based learning into their lectures, several questions may arise, for example: (a) Which game or simulation to select for the specific learning context? (b) Which pedagogic approaches to use to support learning outcomes and activities? (c) What is the validity of using the chosen game or simulation? Kadle (2009:5) raised the following concern:

*'Many organisations, including schools and universities, considering the adoption of digital game-based learning don't know where to begin. The sheer variety and depth of the digital game experience makes it difficult to decide on a strategy and approach'*

This and other researchers (Becker, 2012:2474; De Freitas & Oliver, 2006:251) concerns led to the problem statement for this study:

Educators need a model or a framework to help them to select serious games for the Computer Science class.

## **1.5. Research objectives**

The research problem investigated in this study is based on the realisation that serious games is not part of any class offering in Computer Science at the Vaal Triangle Campus of the North-West University (NWU) and educators have no experience in selecting serious games for use in class. The main objective of the study is as follows:

Identify and recommend a model that can be used to select serious games for the Computer Science class.

## **1.6. Research questions**

In order to address the problem statement and to realise the objective of this study, the following research questions were compiled:

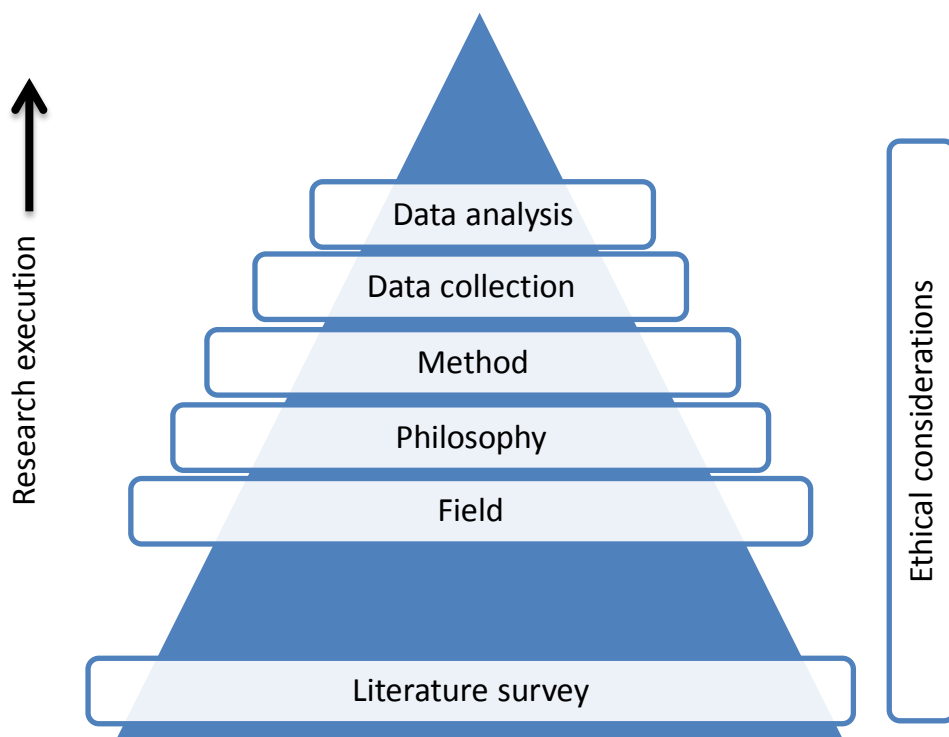
- What models or frameworks are available for selecting serious games for educational use?
- What similarities and differences are there between existing models or frameworks used for selecting serious games for educational use?
- Which model or framework will be the most appropriate for selecting serious games for the Computer Science class?

## **1.7. Research methodology**

The research methodology framework of Myers (2009:26) presented in Figure 1 is followed in this study. This framework consists of the following five focus areas:

- Field: The area in which the research is conducted, namely Computer Science.

- Philosophy: The philosophical foundations of the research that determine the manner in which the information obtained from the research methodology is interpreted. In this study the Critical Social Theory paradigm is followed.
- Method: The method used to execute the research. This study made use of action research as critical social researchers often make use of action research to intervene in the problem situation (Goede *et al.* 2013:248).
- Data collection: The practical techniques used and actions taken to collect data. Mixed methods are used in this study as different methods applied from different paradigms are used to give a better understanding of different aspects of reality (Mingers, 2001:241).
- Data analysis: The statistical or other methods used to process the collected data.



**Figure 1: Research methodology**

(adopted from Myers, 2009:26)

The research methodology is discussed in detail in Chapter 3. A brief summary subsequently follows here. The research topic implies that the research is

investigated in Computer Science. The Critical Social Theory paradigm is selected as research philosophy and action research as the method to mediate the problem situation. Mixed methods such as structured questionnaires and interviews are implemented to collect data.

### **1.8. Research execution**

This study made use of action research as outlined by Susman and Evered (1978). Action research is a five phase cyclic process. The five phases as implemented in this study are briefly outlined and described in more detail in Chapter 3. The five phases are as follows:

- Diagnosing: During the diagnosing phase the problem is identified. Literature revealed the problem that educators find it difficult to select a serious game to assist in teaching and learning. A questionnaire is developed to determine educators' perceptions of serious games and to determine whether the participants also experience the problem identified during the literature survey.
- Action planning: In this phase collaboration between researchers and participants is required. Participants will evaluate existing serious games selection models and frameworks.
- Action taking: During the action taking phase the actions planned in the previous phase will be carried out. Participants evaluate a serious game using the selection models and frameworks provided to them.
- Evaluating: The actions taken during the action taking phase are evaluated during this phase. Participants complete a questionnaire with Likert-scale type and open-ended questions in order to record their experiences with the different selection models and frameworks. Interviews were also conducted to gain more information. The data from the questionnaires are recorded and analysed and the results determine whether it is necessary to repeat the action research cycle.

- Specifying learning: In this phase the study is critically evaluated and advice and possible improvements are identified.

## **1.9. Target population, sample frame, sample method and sample size**

### **1.9.1. Target population**

A research population is typically a very large group of people or objects of interest to the researcher and suitable for the research process. A target population could be, for example, all staff members lecturing Computer Science at universities in South Africa, secondary school children in the Vaal Triangle or people living with cancer in Gauteng. Due to the large size of these populations, it is seldom feasible to study the whole population. Since this study is aimed at investigating an appropriate model or framework to select serious games for the Computer Science class, the target population for this study consist of all educators lecturing Computer Science at Higher Education Institutions (HEIs) in South Africa.

### **1.9.2. Sample frame**

The sample frame for this study includes all registered HEIs in South Africa. It must be noted that Computer Science is not offered at all registered universities. From the sample frame of twenty-five HEIs in South Africa, two campuses in the Gauteng province is selected as they serve a large number of the student population of South Africa and both campuses offer Computer Science as a major subject in their under graduate programmes.

### **1.9.3. Sample method**

This study aims to recommend the most suitable model for selecting serious games for the Computer Science class. As the number of Computer Science educators is limited, this study aims to involve all Computer Science educators at the two selected universities and no sampling method is used.

### **1.9.4. Sample size**

All educators (full-time and part-time) at the two selected universities were contacted and invited to participate in this research.

### **1.10. Ethical considerations**

Permission from both selected universities is obtained to conduct this research and to involve all educators lecturing Computer Science. The following ethical principles are adhered to as recommended by the International Development Research Centre (2011).

Before an individual becomes a participant in the research, he or she is notified of the aims, methods and anticipated benefits of the study. The participants are informed that it's their right not to participate in the study and it is possible to terminate at any point in time. The participants are also informed of the confidential nature of the study. Participants sign a declaration of confirmation of consent.

### **1.11. Layout of the study**

The study comprises of the following chapters:

**Chapter 1 – Orientation:** This chapter serves as an introduction to the research. The main purpose of this chapter is to introduce the concepts covered in the study,

the research problem, objectives, research questions and the research methodology. The target population and ethical considerations are discussed.

**Chapter 2 – Literature study:** The literature survey is outlined in Chapter 2. This chapter focuses on serious games, the advantages of serious games in education and challenges to embed serious games into formal teaching and learning. In the second part of this chapter two serious game selection models, one framework and one project namely the RETAIN model, the four-dimensional framework, the Levee Patroller project and the Magic Bullet model are discussed.

**Chapter 3 – Research methodologies:** Chapter 3 elaborates on the research design by presenting the research paradigms followed in this study. This is followed by a discussion on research methods and data collection techniques used in this study. Furthermore, quality criteria and research validation are outlined.

**Chapter 4 – The research strategy and analysis:** This chapter reports on the research execution. It defines the research strategy, the research environment and two cycles of the action research methodology.

**Chapter 5 – Conclusions, recommendations and future research:** The objective of the last chapter is to reflect on the research conclusions and to align the research objectives and research questions with the findings of the study. Finally, limitations, recommendations and future studies are discussed.

## **1.12. Conclusion**

This chapter served as an introduction to the research. A brief introduction to serious games and serious games in education lead to the problem statement, research objective and research questions. The research methodology, target population, sample frame, sample method and sample size were outlined. Finally ethical considerations and the chapter layout of the study were presented.

## CHAPTER TWO: LITERATURE STUDY

### 2.1. Introduction

This chapter defines serious games and briefly discusses some of the game characteristics for education. Following this is a discussion of models or frameworks, namely the RETAIN model, the four-dimensional framework, the *Levee Patroller project* and the Magic Bullet model that could be used by educators to select serious games to assist in teaching and learning. The chapter concludes with a comparison of the four serious game selection models and framework.

### 2.2. Background

Games can be defined as a physical or mental contest, and played according to specific rules, with the goal to amuse or reward the player (Younis & Loh, 2010:2). When the game is played on a computer, either with the help of the computer or against it, players are engaged in the mental challenges or contests offered by the game for enjoyment, recreation or winning a stake (Zyda, 2005:26).

According to Gros (2007:26) most researchers, game developers, the video game industry, and academia would probably agree to the following seven genres, although they may use different taxonomies to classify games:

- Action games: Reaction-based video games (for example Pokémon, Super Mario Bros).
- Adventure games: Games where the player solves a number of quests in order to progress from scene to scene (like a story) within a virtual game world (for example Myth).
- Fighting games: Games that involve fighting against computer-controlled characters or those controlled by other players (for example Soul Calibur, Tekken).

- Role-playing games: Games where players assume the characteristics or roles of certain fictitious persons or creatures (for example Neverwinter Nights, Alpha Protocol).
- Simulations: Games that are modelled after natural or man-made systems or phenomena and in which players have to achieve particular pre-specified goals to succeed (e.g. fire-fighting, Microsoft Flight simulator).
- Sports games: Games that are based on sports (for example basketball, football) or vehicle racing (e.g. NASCAR, Gran Turismo).
- Strategy games: Games that recreate historical or fictional situations to allow a player to devise an appropriate strategy to achieve the ultimate goal (for example Three Kingdoms, Dawn of Discovery).

Students and young learners of the 21<sup>st</sup> century are exposed to an overabundance of games that include a variety of activities ranging from pure fantasy to real life. Researchers like Squire (2006:19-29) and Prensky (2001:112-117) believed that what seems like *casual play* to a non-participating observer actually involve *deep learning* because players must constantly react to the challenges presented in the game activities in order to solve problems and meet objectives laid out in the game quests. Such learning can be physical, intellectual or emotional.

With this brief background the next section introduces serious games and discusses some definitions of serious games.

### **2.3. Serious games**

In 2002 Ben Sawyer (of the Woodrow Wilson Center for International Scholars in Washington, D.C.) founded the Serious Games Initiative to focus the industry's attention on digital games with objectives beyond pure entertainment – including the use of digital games for health care, business, politics and education (Younis & Loh, 2010:3). Vanden Abeele *et al.* (2011:1) stated:

*'The use of interactive game technology in non-entertainment sectors has become a trend and many health services, social and political institutions, military, government and educational organisations have attempted to transfer knowledge, to teach certain skills or to change attitudes by means of a game that was specifically designed with that purpose in mind'*

Different terms are used by educators to describe serious games, which include: serious games, digital game-based learning (DGBL), video games and instructional video games, to name just a few (Younis & Loh, 2010:3). It is evident from many studies that there are many definitions that describe a game (Michael & Chen, 2006:19; Vogel *et al.*, 2006:231; Garris *et al.*, 2002:442-443). According to Michael and Chen (2006:21) a serious game is a computer-based game with a primary purpose other than entertainment. Many researchers propagate the use of games, often referred to as serious games, in learning and instruction (Wouters *et al.*, 2009:2). In their research Wouters *et al.* (2009:2) argued that the most widely used definitions describe a serious game as a game that is goal-directed, have a competitive activity (against the computer, another player, or oneself) and conducted within a framework of agreed upon rules. In addition, Prensky (2001:121) added that players can monitor their progress towards a set goal (or goals) as games constantly provide feedback.

A serious game for the purpose of this study includes the following attributes: the game is goal-directed, has a competitive activity, and is conducted within a framework of agreed upon rules, enable players to monitor their progress towards the goal, and provide constant feedback.

Different definitions of serious games have many attributes in common and because games encourage players to engage in active learning, it can be used as effective teaching and learning tools. The advantage of these characteristics for teaching and learning are discussed in the next section.

## 2.4. Taking advantage of game characteristics for learning

Many of today's learners are familiar with computer games. Software used to write games has become more affordable. Some game engines are available as open source software with no costs at all. Many commercial engines also have a restricted version available at no cost. Some examples of such engines include Unity, Unreal Engine 3, Source Engine and CryEngine 3. This opens up opportunities for introducing cost-effective customised solutions.

Games allow players to inhabit roles and experience situations that are otherwise inaccessible to them due to reasons like safety, cost and time (Ulricsak & Wright, 2010:5). The virtual environments in which games are played make games a powerful medium for teaching and learning as everything is placed in context and learning no longer means confronting words and symbols separated from the original context. Computer games allow for immersive experiences by allowing the player to get close to applicable challenges and actively make decisions while experiencing the consequences (Engenfeldt-Nielsen, 2011:2). One of the entities of serious games is that it engages the player and the interactive elements appeal to different learning styles. Serious games also positively affect self-motivation, problem-solving, comprehension, decision-making and retention among the players (Engenfeldt-Nielsen, 2011:2; Gee & Schaffer, 2010:3; Rieber *et al.*, 1998). The relationship between the mechanisms of play and learning ensures that players enjoy the learning experience while embedding the information and skills for long-term retention (Engenfeldt-Nielsen, 2011:2; Gee & Schaffer, 2010:3-4).

Younis and Loh (2010:4) claimed that digital games (whether serious or not), share a minimum number of distinguishable characteristics that make them successful and engaging as learning activities. These characteristics include the following (Dickey, 2007:226; Garris *et al.*, 2002:447):

- Back-story and story-line: Every game has a back-story and the player achieves the game goal by moving through the story-line to the end of the story. The story-line contributes to the logical flow of events.

- Game mechanics: Control the functions within the game and makes the physical world of the game behave in a certain way. Game mechanics allow designers to build unique imaginary worlds that users cannot find in other media.
- Fantasy: Games involve imaginary worlds with no connection to real life consequences. This fantasy makes players explore new situations that are not part of their real life activities.
- Rules and/or goals: Games have space and time governed by rules. These rules allow players to apply a wide range of actions within the game context. Serious games have clear sequenced goals that lead to active learning.
- Sensory stimuli (immersive graphical environment): Games allow designers to apply sound effects and dynamic graphics to grab players' attention and motivate them to play and learn.
- Challenge: Games have clear playing goals with uncertain possibilities for achieving them. Serious games usually apply progressive difficulty and provide feedback and score-keeping. Educators can use these challenges in the serious game context to improve teaching and learning.
- Mystery: In most adventure and role-playing games, players explore unknown environments and encounter imaginary situations. This mystery increases their curiosity for playing and drives their learning.
- Control: In playing games players control, direct, and command their play. This control increases their motivation to play and learn. Thus, control allows educators to design interactive learning activities in the game context.

Authentic learning situations and contexts can be built into serious games using these characteristics. Authentic learning situations and contexts emphasise concept building and higher level thinking skills instead of drill-and-practice activities for memorisation and rote learning. According to Younis and Loh (2010:5) there are several approaches that educators could integrate serious games into their classrooms. Some of these approaches include:

- Collaborating: Educators work with developers to create new educational games for teaching and learning (for example new curriculum and instruction).
- Adopting: Educators integrate game activities from commercial off-the-shelf (COTS) games into classroom activities. COTS games have been seen to cross multiple disciplines for example art, English, mathematics and psychology.
- Writing: Allow students to create or write new adventures or stories with game toolsets using a creative story writing 'process'.
- Creating: Have students learn to write (or program) a new game from scratch as a learning activity.
- Adapting: Educators modify (mod or modding as it is known in the gaming industry) commercial games for educational purposes (Van Eck, 2006:18).

A discussion of adapting and modifying serious games, game modding and adopting COTS games for educational purposes is beyond the scope of this study (see Younis and Loh (2010:6) for a brief discussion).

## **2.5. Challenges in embedding serious games into formal education**

Bogost (2010) summarised the limitations and potential of games, as educational tools, as follows. Good games are complex and hard to make; the real promise of games as educational tools is in a game's ability to demonstrate the complexity and interconnectedness of issues; behaviour cannot ever really be changed by a game (a game about nutrition will not magically turn a player healthy); and games can help us shape and explore our values.

Taking Bogost's (2010) ideas as a starting point the important challenge is to identify if a game exists that addresses the identified learning goals. Another criterion in the selection challenge, as stated by Egenfeldt-Nielsen (cited by Ulicsak & Wright, 2010:56), is the important consideration from an educator's perspective: how much will the game make the educator's life easier? According to Sawyer (cited by Ulicsak

& Wright, 2010:56) there are games available but very few of their potential users are aware of them.

The next challenge then is finding relevant games in that area, identify whether one of the games will enhance teaching and learning and if not identify what will be needed for a game to be useful. When considering games it must not just be assumed that games will motivate and engage learners as Squires (2005:3) pointed out. It must be determined whether the use of games is the best option.

Studies have tried to identify the issues involved in selecting, developing and evaluating serious games used for education. One example is the Games for learning institute (Hoffman, 2010). They created a rubric for educators, researchers and designers. The rubric offers seventeen different areas on a five-point scale whereby designers can evaluate educational games against three criteria:

- Technical implementation: The activity of programming and executing a design pattern into a working version of the game. Includes the seamless integration of design elements within gameplay.
- Educational appropriateness: The ability of the game to address educational/curricular outcomes and the player(s) knowledge/ability relative to the educational content being addressed.
- Overall integration with goals: The integration of the design pattern being considered with the other elements within the game, and within overall gameplay and educational goals.

In order to address some of the challenges a number of other evaluation frameworks that are concerned with learning and new technology already exist. The following list a few of these frameworks:

- The Perspectives Interaction Paradigm by Squires and McDougall (1994) considers the interactions between educator, student and software.

- The CIAO! Framework (Jones et al., 1996) considers the context, interactions (between learners and technology), attitudes and outcomes advocating the use of interviews, observations, document analyses as well as surveys.
- The Flashlight framework (Ehrmann, 1999) seeks to examine the relationship between technology, the activity for which it is used and the educational outcome, primarily through means of surveys.
- Frameworks designed to evaluate the integration of technology into teaching, for example the TILT, CIAO! and Flashlight frameworks were discussed by Oliver (2000).

These frameworks however, were designed to evaluate technology in general and not specifically for evaluating games or simulation. Research in game studies on the other hand, focused on approaches based on leisure games and therefore do not focus enough on learning theory, context and practice (de Freitas & Oliver 2006:262).

A significant obstacle for introducing simulations and games in tertiary education was the lack of a useful framework for evaluating serious games (de Freitas, 2006:250-251). In the next sections the RETAIN model, the four-dimensional framework, the Levee Patroller project and the Magic Bullet model are discussed.

## **2.6. Models and frameworks to evaluate serious games**

Two serious game selection models, one framework and one project namely the RETAIN model, the four-dimensional framework, the Levee Patroller project and the Magic Bullet model that have received a lot of attention in the literature are discussed next.

### 2.6.1. The RETAIN model

Gunter *et al.* (2008:534) argued that in order to create a successful serious game that is intended for educational purposes much more than merely an engaging atmosphere and the incorporation of academic content are needed. Every stage of the design and production require a lot of thought and planning to make sure that the media and content collaborate that content is integrated and intertwined closely with gameplay while teaching and learning are supported with well-planned feedback and hints (Gunter *et al.*, 2008:534).

The Relevance, Embedding, Transfer, Adaption, Immersion and Naturalisation (RETAIN) model is based on three existing theories: Keller's Attention, Relevance, Confidence/Challenge, and Satisfaction/Success (ARCS) model and Gagné's Events of Instruction that are applied against a backdrop of Bloom's hierarchical structure for knowledge acquisition as well as Piaget's ideas on schema (Gunter *et al.*, 2008:520). Gunter *et al.* (2008:511) stated:

*'The RETAIN design and evaluation model for educational games was developed to aide in the evaluation of how well academic content is endogenously immersed and embedded within the game's fantasy and story content, promotes transfer of knowledge, and encourages repetitive usage so that content becomes available for use in an automatic way'*

Ulicsak and Wright (2010:58) summarised the purpose of the RETAIN model as (a) to support game development, and (b) in the set of instructions developed, assess how well educational games contain and incorporate academic content. Ulicsak and Wright (2010:59) briefly summarised the six areas of the RETAIN model the designer or educator needs to consider once the learning goals have been defined, as follows:

- **Relevance:** Materials presented must be relevant to the learners in terms of their needs and learning style. In addition to this instructional units should be relevant to each other. Instructional units must link together and become more advanced as the learner's skill increase.

- Embedding: Evaluating how well academic content is embedded in the game’s story or fantasy.
- Transfer: Access how knowledge is transferred from previous tasks and scenarios to other areas.
- Adaption: The adaptability created as a consequence of transfer. Refer to learners being forced to change or create new knowledge to deal with something that does not fit existing ideas and understanding.
- Immersion: Assessing the learners’ intellectual investment in the context of the game.
- Naturalisation: To access how well learners develop automated or spontaneous use of information.

The evaluation guidelines in the RETAIN model are represented in table format. The suggested elements are in the first column of the table and a bottom-up hierarchy is assumed in which the evaluation of one element builds upon the previous element. Each of these elements can be divided into four levels: 0, 1, 2 and 3, where Level 0 indicates the game design does not meet that aspect, while Level 3 means there is a strong correlation between the game and that specific aspect. For example, Naturalisation would be classified as Level 0 if there is little opportunity to use the information already presented again; Level 1 if it does require the player to use the information and encourage him/her to process it more quickly; Level 2 if the player has to make judgements about ideas and materials; and Level 3 if the player can incorporate information from multiple sources and spontaneously and habitually use it. A value system associated with the set of instructions and the evaluation criteria to determine how the proposed designs can be assessed is outlined in Table 1.

**Table 1:** The RETAIN rubric

(Gunter *et al.*, 2008:524)

	<b>Level 0</b>	<b>Level 1</b>	<b>Level 2</b>	<b>Level 3</b>
<b>Relevance</b>	The story/fantasy creates little stimulus for learning and is in a format that is either of little interest to the	The story/fantasy is age/content appropriate or it has a limited educational focus and little progression.	In addition to overcoming limitations and/or adding to Level 1 features, the following are also present:	In addition to overcoming limitations and/or adding to Level 1 & 2 features, the following are also present:

	<p>players/learners or does not utilise advanced organisers.</p> <p>The player/learner does not know the state of the game or the required learning content based on the choices presented.</p>	<p>The pedagogic elements are somewhat defined but occasionally players/learners are allowed by the embedded fantasy to become engaged in inappropriate content or contexts.</p>	<p>Specific didactic content is targeted and learning objectives are clearly defined.</p> <p>Creates interest in what is to be learned and a natural stimulus and desire to learn more.</p>	<p>Is relevant to players'/learners' lives, (real or imagined) and/or the world around them using characters and themes familiar to them.</p> <p>Matches the players/learners to their appropriate developmental level by providing adequate cognitive challenges.</p>
<b>Embedding</b>	<p>The teachable' moments disrupt the players'/learners' gameplay that is the flow of the game has no interactive focus/hook either on the emotional, psychological, physical, or intellectual level.</p>	<p>Didactic elements are both present but are not cohesively integrated – one or the other is added as an afterthought to the first.</p> <p>Content to be learned is exogenous to the fantasy context of the game.</p>	<p>In addition to overcoming limitations and/or adding to Level 1 features, the following are also present:</p> <p>Allows for extended experiences with problems and contexts specific to the curriculum.</p> <p>Intellectual challenges are presented to players/learners of sufficient level to keep them interested in completing the game.</p>	<p>In addition to overcoming limitations and/or adding to Level 1 &amp; 2 features, the following are also present:</p> <p>Involves the players/learners both mentally and emotionally in such a way that they are conditioned to accept change and invest in the belief.</p> <p>Educational content is fully endogenous to the fantasy context.</p>
<b>Transfer</b>	<p>Offers no anchored or scaffolded levels of challenge, no evidence of using integrated content from previous levels, or little challenges at an increasing level of difficulty.</p> <p>Knowledge process is not</p>	<p>Offers levels of challenge that emphasise similar lines of thought and problem analysis to be applied to other implied contexts.</p> <p>Contains 3D cues and interactive animation that facilitate the</p>	<p>In addition to overcoming limitations and/or adding to Level 1 features, the following are also present:</p> <p>Players/learners are able to progress through the levels easily.</p> <p>Active problem-</p>	<p>In addition to overcoming limitations and/or adding to Level 1 &amp; 2 features, the following are also present:</p> <p>Includes authentic real life experiences that reward meaningful 'post-event'</p>

	mapped to targeted academic content.	transfer of knowledge during pedagogic events.	solving is required to move to the next level.	knowledge acquisition.
<b>Adaption</b>	<p>Fail to involve the players/learners in an interactive context.</p> <p>Information is not structured in a way that can be at least partially grasped by the learner.</p> <p>Does not sequence the material that is to be learned.</p>	<p>Builds upon the player's/learners existing cognitive structures.</p> <p>New content is sequenced based on the principle of cognitive dissonance—as a result players'/learners' need to interpret events in order to determine what about the new content contradicts with they already know.</p>	<p>In addition to overcoming limitations and/or adding to Level 1 features, the following are also present:</p> <p>Instruction is designed to encourage the players/learners to go beyond the given information and discover new concepts for themselves.</p> <p>Content is sequenced in such a way as to require players/learners to identify old schema and transfer it to new ways of thinking.</p>	<p>In addition to overcoming limitations and/or adding to Level 1 &amp; 2 features, the following are also present:</p> <p>Makes learning an active, participatory process in which the players/learners construct new ideas based upon their prior knowledge.</p> <p>Presents information that focuses on external or internal characteristics that enable the learner to associate new information with previous knowledge.</p>
<b>Immersion</b>	<p>Provides no progressive, formative feedback during each unit of gameplay.</p> <p>Presents little or no opportunity for reciprocal action and active participation for players/learners.</p>	<p>Elements of play are not directly involved with the didactic focus, but they do not impede or compete with pedagogic elements.</p> <p>Presents some opportunity for reciprocal action in a defined context, that is, a context that is meaningful, repeatable, and interactive, but players/learners do not feel fully interactive in the learning.</p>	<p>In addition to overcoming limitations and/or adding to Level 1 features, the following are also present:</p> <p>Requires the player/learner to be cognitively, physically, psychologically, and emotionally involved in the game content.</p> <p>The use of mutual modelling creates a shared responsibility for learning among</p>	<p>In addition to overcoming limitations and/or adding to Level 1 &amp; 2 features, the following are also present:</p> <p>Presents opportunity for reciprocal action and active participation for players/learners.</p> <p>Presents both the environment and opportunity for belief creation.</p>

			the participants.	
<b>Naturalisation</b>	<p>Presents little opportunity for the mastery of facts or a particular skill.</p> <p>Target content and skills are rarely revisited.</p> <p>Little opportunity is given to build upon previous knowledge and/or skills in a logical and sequential manner.</p>	<p>Replay is encouraged to assist in retention and to remediate shortcomings.</p> <p>Improves the speed of cognitive response, automaticity, and/or visual processing.</p>	<p>In addition to overcoming limitations and/or adding to Level 1 features, the following are also present:</p> <p>Encourages the synthesis of several elements and an understanding that once one skill is learned it leads to the easier acquisition of later elements.</p> <p>Require the players/learners to make judgments about ideas and materials.</p>	<p>In addition to overcoming limitations and/or adding to Level 1 &amp; 2 features, the following are also present:</p> <p>Cause players/learners to be aware of the content in such a way that they become efficient users of that knowledge.</p> <p>Cause the players/learners to spontaneously utilise knowledge habitually and consistently.</p>

The RETAIN model displays a twofold weighting system. The first scaling, as mentioned above, occurs within the levels across the top of Table 1 (the designers deliberately choose the term *level* to reflect the levelling concept utilised in the gaming milieu). Level 0 implies that the conceptual construct for that element is missing; at Level 1 that conceptual construct is there but very minimal and increases as one moves to Levels 2 and 3.

Aspects are ordered by importance for the second scaling – from least to most important, they are: Relevance, Immersion, Embedding, Adaption, Transfer and Naturalisation. In this weighting, points are awarded as more proof that, element’s construct is present, according to the specifications provided in the specific cell of Table 1. The weighting chart is shown in Table 2.

**Table 2:** The RETAIN weighting chart

(Gunter *et al.* 2008:531)

	<b>Order of importance</b>	<b>Level 0</b>	<b>Level 1</b>	<b>Level 2</b>	<b>Level 3</b>
Relevance	1	0	1	2	3

Embedding	3	0	3	6	9
Transfer	5	0	5	10	15
Adaptation	4	0	4	8	12
Immersion	2	0	2	4	6
Naturalisation	6	0	6	12	18

In order to obtain the weighting of a specific element at a specific level multiply the level number with that element's order of importance number. For example if a game fulfils Level 0 of Adaptation it is worth zero points ( $0*4$ ), Level 1 four points ( $1*4$ ), Level 2 eight points ( $2*4$ ), and Level 3 twelve point ( $3*4$ ). Since Relevance is seen as a less essential aspect of serious game design, this would mean if a game fulfil Level 1 requirements it will be worth one point ( $1*1$ ), Level 2 two points ( $2*1$ ) and so on.

Each serious game or game design could be assessed using this framework according to Ulicsak and Wright (2010:59). If a game fulfils Level 3 at all aspects it would be awarded a maximum of 63 points. Based on these scores the most appropriate game would be constructed or selected for use.

### **2.6.2. The four-dimensional framework**

The lack of a useful framework resulted in a significant obstacle for using simulations and games in tertiary education (de Freitas, 2006:250-251). De Freitas and Oliver (2006:249-264) proposed the four-dimensional framework that consists as a set of four interrelated elements. The framework arose from work with educators and learners seeking to understand more about how games are selected and used (de Freitas & Jarvis, 2008:216). The purpose of this framework can be summarised as follows:

- to help educators select appropriate games and simulations as teaching tools; and
- to help educators evaluate the potential of using games- and simulation-based learning in the classroom; and

- support more critical approaches to this form of games and simulations; and
- to help researchers to assess serious games; and
- to assist educational designers to consider educationally specific factors.

The founders of the four-dimensional framework (de Freitas & Oliver, 2006:262) explained how the four-dimensional framework was successfully working as a design tool as well as the original intention of an assessment tool. Their argument was:

*‘Although a number of frameworks exist that are intended to guide and support the evaluation of educational software, few have been designed that consider explicitly the use of games or simulations in education. Similarly, research in game studies has generally focused upon approaches based upon playing leisure games, and therefore do not take enough account of factors including the context, learning theory and practice and the attributes of the learner and learner group’*

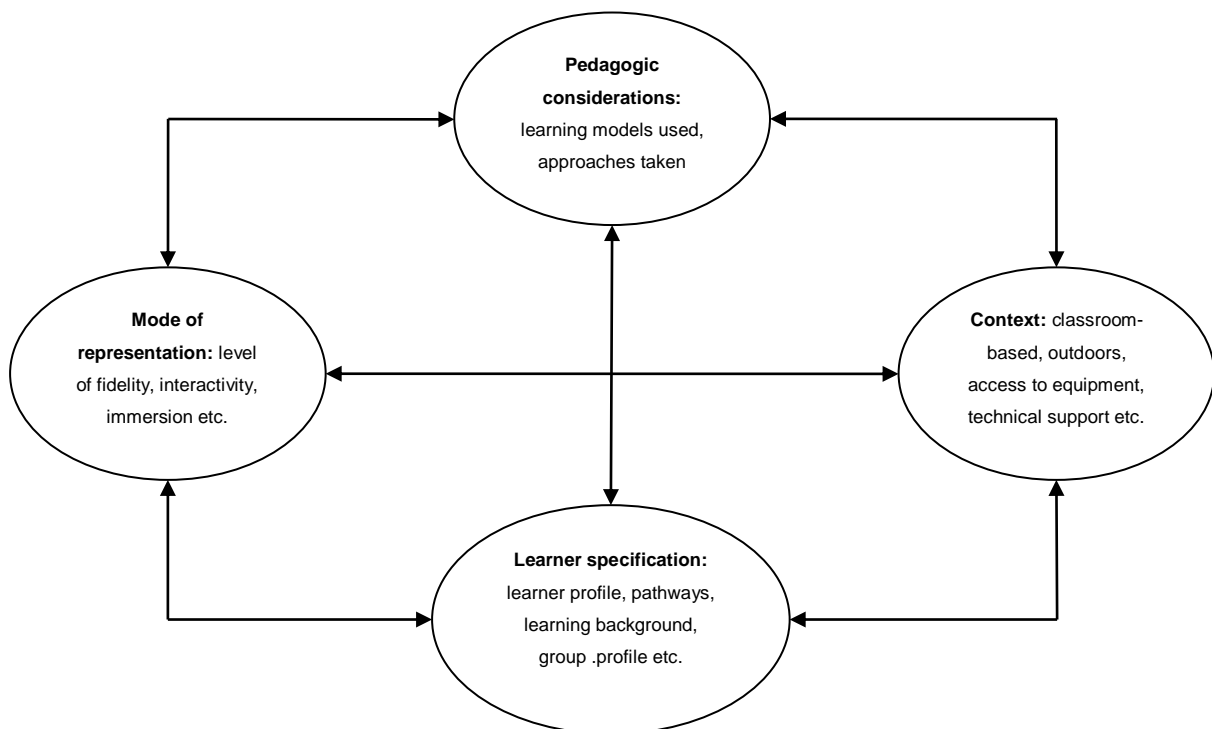
The four-dimensional framework is a structured analysis designed in the first place to assist in the processes to select the right content and games, and secondly to find the best way to apply it within the learning context.

As mentioned above, the four-dimensional framework consists of a set of four interrelated elements; Context, learner specification, mode of representation and pedagogic considerations. Ulicsak and Wright (2010:62) summarised the elements of the four-dimensional framework, as shown in Figure 2, as follows;

- Context covers where the learning occurs, ranges from the macro level, that is historical, political and economic factors (for example, are you playing because it is a school directive?), to the micro-level (that is the educator’s background and experience, cost of game licenses etc.).
- Learner specification for the individual learner or the group, requires the educator to consider the learners’ preferred learning style, previous knowledge and what methods would best support them given their differing needs.

- Mode of representation entails how high the levels of fidelity need to be, how interactive the game is, and how immersive the game might be. The representation also covers diegesis, the separation of the immersion aspect with the reflection around the process of playing the game. Diegesis here is a term borrowed from film study to refer to the story world in a film. Most importantly it highlights the potential of briefing and debriefing to reinforce the learning outcomes.
- Pedagogic principles (for example, associative, cognitive, and situative) require the educator to reflect on the learning models and framework that enables them to prepare appropriate lesson plans.

It is important to realise that these elements cannot be considered individually; they all are interrelated to one another, as shown in Figure 2.



**Figure 2:** A framework for evaluating game-based and simulation-based education

(De Freitas & Oliver, 2006:253)

The framework provides for each element a set of checklist questions to be addressed iteratively. These questions can be very broad, for example ‘*What is the*

context?' to very specific, for example 'What level of fidelity needs to be used to support learning activities and outcomes?' The user may change the responses in accordance with later answers.

De Freitas and Oliver (2006:256) demonstrated a layout of checklist questions in Table 3.

**Table 3:** Checklist for evaluating the use of educational games and simulations

(De Freitas & Oliver, 2006:256)

<b>Context</b>	<b>Learner specification</b>	<b>Pedagogic consideration</b>	<b>Mode of representation</b>
What is the context for learning? (e.g. school, university, home, a combination of several)	Who is the Learner?  What is their background and educational history?	Which pedagogic models/frameworks and approaches are being used?	Which software tools or content would best to support the learning activities?
Does the context affect learning? (e.g. level of resources, accessibility, technical support)	What are the learning styles/preferences?  Who is the learner group?	Which pedagogic models/frameworks and approaches might be most affective?	What level of fidelity needs to be used to support learning activities and outcomes?
How can links be made between context and practice?	How can the learner or learner group be best supported?  In what ways are the groups working together (e.g. singly, partially in groups) and what collaborative approaches could support this?	What are the curricula objectives? (list them)  What are the learning outcomes?  What are the learning activities?  How can the learning activities and outcomes be achieved through specially developed software (e.g. embedding into lesson plans)?  How can briefing/debriefing be used to reinforce learning outcomes?	What level of immersion is needed to support the learning outcomes?  What level of realism is needed to achieve learning objectives?  How can links be made between the world of the game/simulation and reflection upon learning?

According to de Freitas and Oliver (2006:262) the current structure of the questions mean they are suited for educational software designers or for those in educational advisory roles. If the questions need to be used directly by an educator they may need refining.

### 2.6.3. The Levee Patroller project

A number of serious games, for example Hazmat, Hot Zone, PeaceMaker, and Virtual U,<sup>1</sup> were created in reaction to the interest in the use of video games in education (Harteveld *et al.*, 2007:128). The problem identified by Harteveld *et al.* (2007:128) is that many attempts to produce serious games have not documented or published the underlying design philosophies – ‘*although created in a carefully controlled university environment*’ (Harteveld *et al.*, 2007:128). As a result of game designers and writers not documenting or publishing their design philosophies, it is difficult for the emerging field of game studies<sup>2</sup> to establish principles, processes and procedures for the deployment of games in education. Shaffer *et al.* (2005) emphasised the importance of underlying design and learning theories: ‘*This interest in games is encouraging, but most educational games to date have been produced in the absence of any coherent theory of learning or underlying body of research. We need to ask and answer important questions about this relatively new medium. We need to understand how the conventions of good commercial games create compelling virtual worlds*’ (Shaffer *et al.*, 2005:111).

The need for an underlying theory has been confirmed by numerous educational games that have been designed in the past (Harteveld *et al.*, 2010:317). Harteveld also argue that games produced so far are not as compelling as leisure games and numerous design flows and learning content is ineptly integrated into the game (Harteveld *et al.*, 2010:317).

Harteveld *et al.* (2007:129) created the game *Levee Patroller*<sup>3</sup> for the Dutch water boards with the objective to identify flaws in levees, the artificial and real barriers that stop the inhabitants and goods of those in the Netherlands being washed away. Their goal was not only to develop the game but ‘*to develop an underlying theory*

---

<sup>1</sup> *Hazmat: Hot Zone* and *PeaceMaker* have been developed at Carnegie Mellon University, and *Virtual U* has been developed by a team consisting of independent game developers and Stanford University.

<sup>2</sup> ‘Although the field of serious games might be young, it is strongly affiliated with the field of simulation and gaming, in which research has been done for more than fifty years’ (Harteveld *et al.*, 2007:129).

<sup>3</sup> ‘*Levee Patroller*, has been developed by an interdisciplinary team of Delft University of Technology, of GeoDelft, a research institute for geo-engineering in the Netherlands, and of the Dutch water boards (Harteveld *et al.*, 2007)

which will guide future developers in making entertaining as well as educational serious games' (Harteveld *et al.*, 2007:129). This discussion will only focus on the design philosophy of *Levee Patroller* and not on the mechanics and implementation of the game.

All games involve learning, for example eye-hand coordination skills and visual-spatial skills (Crawford, 2006; Gee, 2004:40-41) but not all games involve education. The alignment between the learning of the content and the game itself, differentiate serious games from entertainment but is at the same time the hardest effort in developing serious games. Harteveld *et al.* (2007:131) drew a line between serious and entertainment games: '*Serious games need to educate the player with a specific type of content, whereas entertainment games need to entertain the player with whatever; racing, puzzles, it does not really matter, as long as the player enjoys it. With serious games, content is superimposed on the player; while for entertainment games the content does not really matter*' (Harteveld *et al.*, 2007:131). The question now is how to superimpose educational content on the learner while still making it fun?

This question does not bother entertainment game designers frequently because their main aim is to make the game fun. Serious game designers, on the other hand, have multiple objectives, the game must be compelling and fun but at the same time educating and realistic. To create this, they need to trade-off certain aspects of a game. These trades-offs need to take into account that the system (the game itself) as a whole stays in balance. If these objectives are not met the game may lose<sup>4</sup> its harmony (Harteveld *et al.*, 2007:131).

The creators of the *Levee Patroller* realised that three objectives need to be achieved in the design of a serious game namely *fun*, *learning* and *validity*. A game that is not *fun* is not a game and a serious game is a game. A serious game needs to make use of pedagogical methods and theories to guarantee *learning*. As *validity* is related to content, serious games should teach relevant content that can be applied

---

<sup>4</sup> Do not confuse *loose* with *lose*; loose means 'not fixed in place or tied up' (a loose tooth), while lose means 'have something taken away' (she might lose her job) (Compact Oxford English Dictionary, 3<sup>rd</sup> edition, revised, Oxford University Press, 2008).

outside the game world. Thus, there is a fine balance when designing or using games with an educational focus (Ulicsak & Wright, 2010:64). The *Levee Patroller* creators' approach was to divide serious games into three areas for consideration: pedagogy (learning), game (fun) and reality (validity). These three areas and the attributes associated with them are depicted in Table 4.

**Table 4:** Area and attributes of a serious game

Area	Pedagogy (learning)	Game (fun)	Reality (validity)
Attributes	Reflection	Harmony	Learning objectives
	Experience	Uncertainty	Target group
	Low resource demanding	Interactivity	Challenge
	Exploration	Engaging	Clients
	Incremental	Flow	Organisation

Following is a brief discussion of the attributes of each of the three areas shown in Table 4.

#### 2.6.3.1. *Pedagogy (learning) area*

Many learning theories like behaviourism, cognitivism, constructivism and situated learning can be applied to serious games (Egenfeldt-Nielsen, 2005). Some important elements can be applied from each of these theories. These elements include:

- Reflection: Harteveld et al. (2007:132) advocated the need for reflection. Reflection can be stimulated by an instructor, but is better when included in the game. Reflection is important for it takes the player's mindset from specific spontaneous concepts towards abstract scientific concepts.
- Experience: Learning should happen alongside the doing or there should be learning-by-doing. Learners should experience the learning rather than being given windows of text.

- Low resource demanding: The third area is giving sufficient information but not too much to distract the learner or create information overload. Examples thereof are time pressures, too much information or other factors inside the game environment.
- Exploration: The learner needs to be active and have a participative attitude while playing and the game should encourage exploration rather than constantly directing the player.
- Incremental: Finally from a pedagogical perspective, learning should be incremental otherwise it will be too much for a player to grasp as this is the way the human brain functions. Players should acquire knowledge and integrate it into existing structures.

#### 2.6.3.2. **Game (fun) area**

The characteristics of this game component can be summarised as follows:

- Harmony: As games are systems (Salen & Zimmerman, 2004:4) all components and elements of the game are interdependent on each other. Game worlds need to be coherent and consistent, that is, be harmonious. This could involve a degree of fidelity but is not essential. Creating such an environment is difficult as reality is not coherent.
- Uncertainty: Serious games need an element of uncertainty and randomness because that makes them challenging and enhances enjoyment. The player should not suspect what is going to happen next or whether he or she is going to achieve the goal or not.
- Interactivity: Games should be interactive and the decisions made should impact the outcome.
- Engagement: Games should be engaging, so there needs to be rewards for actions (this feedback need not necessarily be points, though these are engaging) and keep the attention of the player.
- Flow: Games need certain tasks that can be frustrating but obtainable. Good games ensure that the player gets into the flow, meaning that a task can be

frustrating but practicing makes it easier. The difficulty rate of the game needs to increase and if the player masters some of the skills, it needs to become more advanced.

#### 2.6.3.3. **Reality (validity) area**

Reality is context specific, unlike the other two attributes that are more generic and can almost be applied to any type of game. The reality attributes are as follows:

- Learning objectives: The learning objectives for the game need to be accurately defined so that it is clear to the learner to understand.
- Target group: Careful consideration is needed to determine the ability of the target group, for example, are they experienced game players?
- Challenge: The player needs to know that the challenge of the game is the task that needs to be learnt and the learning is not an add-on, otherwise he or she may learn to play the game and not the core material.
- Clients: Designers must ensure that the expectations of the clients are understood and considered within the game.
- Organisation: The organisation within the game reflects what would actually occur.

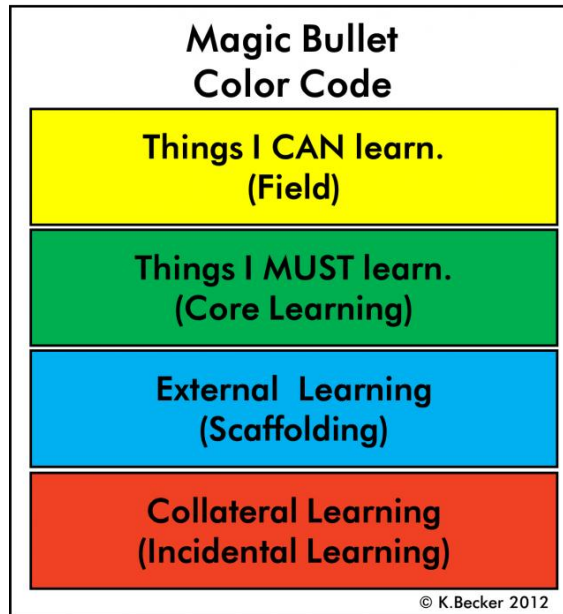
By considering each attribute in turn, game developers and educators can design or select games where these three factors are in balance. The criteria that Hartevelde *et al.* (2007:1-12) produced are intended to constitute a number of concrete design requirements for serious games and there is no reason these requirements are invalid when selecting serious games (Ulicsak & Wright, 2010:66).

#### 2.6.4. **The Magic Bullet model**

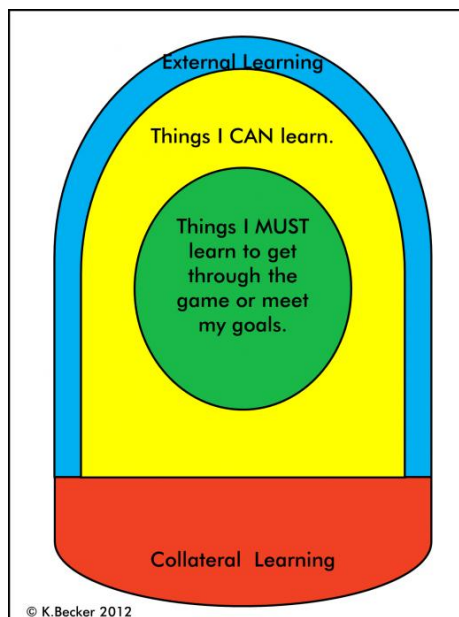
In her conference paper titled '*Battle of the Titans: Mario vs MathBlaster*' Becker (2007) explained her Instructional Ethology Methodology intended to analyse video

games for learning in a formal manner. From her Instructional Ethology Methodology a by-product called the Magic Silver Bullet Model emerged. Becker analysed gameplay logs and concluded that all learning that take place can be classified into four broad categories. During gameplay some learning may occur that was never planned by the designers and not all learning during gameplay is necessary to win the game. Becker classified learning in games in four sets where learning belongs to at least one of the four sets (Becker, 2012:2475). The four sets are colour-coded as shown in Figure 3 and described as follows:

- Things we CAN learn while playing a game. When the game was designed specific learning elements were included as a deliberate goal by the creators of the game. These learning elements can include learning from all domains (cognitive, psychomotor and affective) and all categories (remembering, understanding, applying, analysing, evaluating and creating) (Anderson *et al.*, 2001). Learning is not essential in order to achieve the game's goal.
- Things we MUST learn in order to complete the game. This category consists of only those items that are crucial for winning or to complete the game. It may sometimes be necessary to qualify these items with an if-then statement as many games allow for more than one way to win or to get to the end of the game.
- Things we learn as a result of playing the game but are not part of the game (collateral learning). This category includes other things that can be learned or an emergent behaviour that are not part of the game and do not impact the player's success in the game.
- Things we learn outside the game that are helpful when the game is played again (external learning). External learning takes place outside the game for instance in fan sites or social events or where game guides are provided.



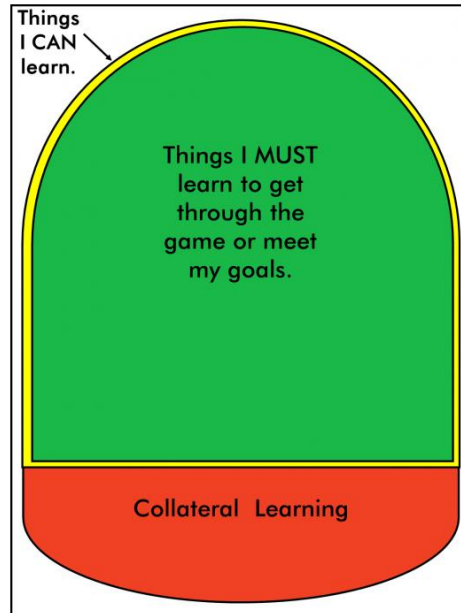
**Figure 3:** The Magic Bullet colour code  
(Becker, 2013:4)



**Figure 4:** The Magic Bullet (good balance)  
(Becker, 2013:5)

Figure 4 depicts what Becker calls a good-balanced game. What I MUST learn is completely inside what I CAN learn and it is possible that external and collateral

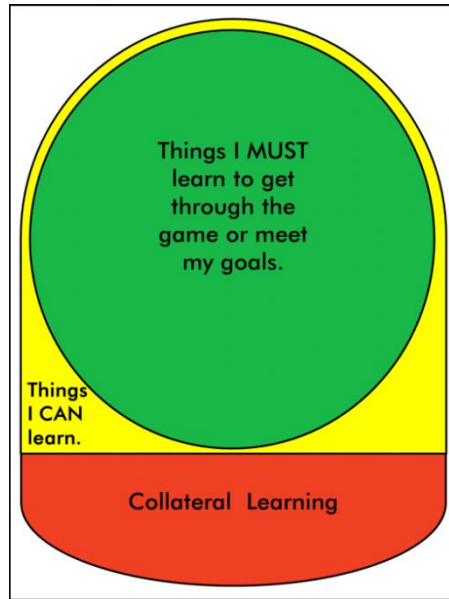
learning can also take place. This means that the game provides much more to learn than just what is necessary to meet the goals or to complete the game.



**Figure 5:** The Magic Bullet (MUST learn = CAN learn)

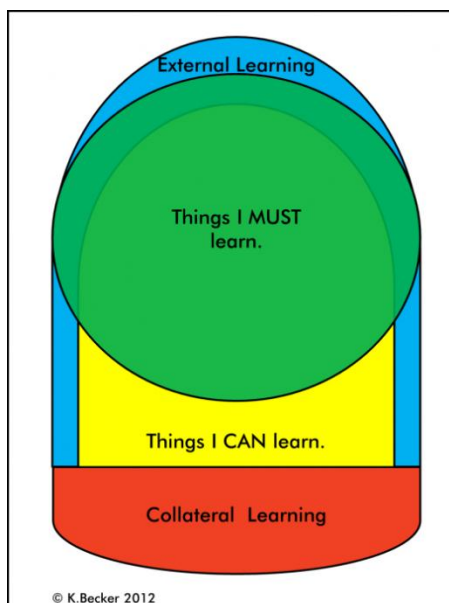
(Becker, 2013:7)

Figure 5 shows a situation where almost all learning provided by the game is necessary to complete or win the game, in other words what I CAN learn is also what I MUST learn. Collateral learning is possible but no external learning is provided. This situation often requires that the game must be played several times and at different levels.



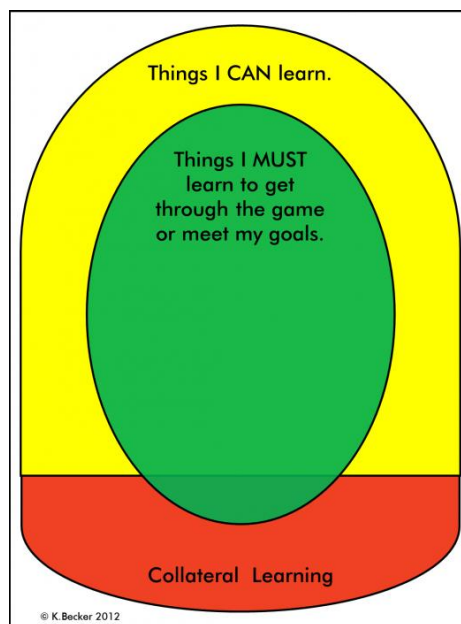
**Figure 6:** The Magic Bullet (MUST learn ~ CAN learn)  
(Becker, 2013:7)

The scenario in Figure 6 indicates that the MUST learn and CAN learn categories are in a certain relation to one another. This case can be very exciting for some players but very frustrating to others. Similar to the case where MUST learn equals CAN learn, this case also requires that the game often be played several times and at different levels. Collateral learning is possible.



**Figure 7:** The Magic Bullet (MUST learn > CAN learn)  
(Becker, 2013:8)

In the case presented in Figure 7 where MUST learn > CAN learn, the player needs outside help or resources to get into the game or to make any progress while playing the game. While this can be a good game it may have serious implications for audiences and may have an impact on support requirements. This situation is very risky in serious games.



**Figure 8** The Magic Bullet (MUST learn – includes collateral learning)  
(Becker, 2013:10)

According to Becker the situation shown in Figure 8 can make a great game and very useful in serious games because games do not always need to be self-contained. Collateral learning is necessary to achieve some of the MUST learning.

## 2.7. Discussion of the models and the framework

Each of the models and the framework that were discussed focuses and emphasises different aspects or elements of serious games. The RETAIN model developed by Gunter *et al.* (2008:511-537) focuses on elements internal to the game. De Freitas and Oliver (2006:249-264), in their four-dimensional framework, focus on the

iterative process of game selection and integration. Hartevelde *et al.* (2007:1-12) stressed the need for balance between learning (pedagogy), game (fun) and reality (validity) in their Levee Patroller project while Becker (2012:2474-2479) creates a visual representation of all learning that takes place in a game in the Magic Bullet model. This representation can then be used to evaluate a game to see if learning is distributed in an appropriate way.

One aspect that is common to the first models and the framework, but absent from the last model is the importance of considering context. Šisler and Brom (2008:11) summarised this as follows:

*'It essentially seems that when a game is supposed to be used in a formal school environment, the context of game-based learning is probably more important than the specific features and/or content of the game itself. By context here we mean both the contemporary educational practice, i.e. the national curricula, and the learning activities and discourse surrounding the particular educational game (for example supportive educational materials, students' presentations, teachers' lectures following the in-game experience, etc.)'*

A clear consideration of how a serious game will achieve the educators' goals is needed if a commercial game is to be used effectively in class and the educator will need to have a clear idea of the learning outcomes, whether it is *understanding why*, or *knowing how* to perform a task (Ulicsak & Wright, 2010:67) – although not an explicit part of any of the models and the framework discussed above. It is necessary to consider how games will be integrated with other practices to teach and achieve the learning goals. In the first models and the framework reflection has been mentioned as an integrated part of the game but also as external to the game. Reflection is very important as Klawe (1998, cited by Egenfeldt-Nielsen *et al.*, 2008:218) demonstrated that a player is less likely to become aware of the structures and concepts that were integrated into the game if the player become immersed into a game. This means that players may apply the knowledge in the game context, but not necessarily in other contexts (Ulicsak & Wright, 2010:67). Mediated discussions are not the only way of ensuring retention. Klawe and Phillips

(1995:1) found that students were more able to transfer their learning when they write down problems while being solved as part of the game.

### **2.7.1. Similarities and differences**

Although the focus of each model is different, the attributes evaluated by all the models and framework need to be compared in order to find the model that is best suited for selecting serious games for the Computer Science class. Pedagogy is an important attribute and present in the RETAIN model, the four-dimensional framework and the Levee Patroller project. The pedagogic dimension according to De Freitas and Oliver (2006:254) reflected on the methods, theories, models and frameworks used to support learning practises. Harteveld *et al.* (2007:1-12) referred to pedagogic as learning theories that can be applied to serious games, such as behaviourism, cognitivist, constructivism and situated learning.

Relevance is an element of the RETAIN model and refers to the relevance of the learning material to the learners, their needs and their learning styles and can be linked to pedagogic requirements. Embedding, another attribute of the RETAIN model, can also be linked with pedagogy as it assesses how closely the academic content is linked with the fantasy/story content of the serious game (Gunter *et al.* 2007:527).

The next attribute in consideration is the learner. The four-dimensional framework includes the learner as an area of consideration by referring to the learner's age, level, educational background, learning style and learning preferences. Relevance in the RETAIN model refers to the relevance of the learning material to the learners, their needs and their learning styles (Gunter *et al.*, 2007:527). The Levee Patroller project refers to the learner within the reality area of consideration as the clients or target group who will make use of the serious game.

Harteveld *et al.* (2007:1-12) referred to fun as an area of consideration. Fun is not referred to directly by the RETAIN model and the four-dimensional framework, but both include immersion. Immersion according to Gunter *et al.* (2007:529) refers to

the student being fully engaged in the context of the game. The four-dimensional framework includes immersion within the mode of a presentation dimension that refers to the interactivity, levels of immersion and fidelity used in the game (De Freitas and Oliver, 2006:254). It can be argued that if a game is not fun it will not have a full immersion effect on a student. Attributes such as the story-line, game mechanics, fantasy, challenge, mystery and fun can contribute to the immersion effect and the full engagement (intellectual investment) of a student.

The RETAIN model evaluates the internals of the game in more depth by considering transfer of knowledge and adaption capability of the player and the player's ability to naturally use knowledge gained by playing the game. None of the other models or frameworks evaluate these aspects in such depth.

The four-dimensional framework also considers context being anything that can influence the successful use of the game in class. Contexts as referred to by the four-dimensional framework considers other external influential attributes such as the availability of computer facilities, hardware requirements, accessibility to the facilities and technical support. These are also important attributes when selecting a game for class use and no other model includes these.

The Magic Bullet model uses a different perspective and cannot directly be compared with the other models and the framework in terms of the attributes evaluated.

All attributes of the Levee Patroller project can be linked to attributes in the four-dimensional framework and RETAIN model. Thus for this study the four-dimensional framework, RETAIN model and Magic Bullet model are evaluated further.

## **2.8. Conclusion**

There are many models and frameworks described in the literature that can help with the evaluation and development of games. In this chapter the most prominent models and frameworks for serious games were discussed and compared. The four-

dimensional framework, RETAIN and Magic Bullet models were selected to evaluate further within the action research cycle as described in Chapter 4. The next chapter concentrates on research methodologies.

## CHAPTER THREE: RESEARCH METHODOLOGIES

### 3.1. Introduction

When new knowledge is added to a subject or a topic research takes place (Mouton, 2001:138) and when a science is 'producing knowledge' it is referred to as scientific research by Neuman (2011:9). The researcher has to make the correct choices regarding research methods and techniques and the significance of the systematic approach towards the research process is emphasised by Saunders *et al.* (2009:3).

This chapter focuses on research methodologies and specifically on mixed methods in Information Systems (IS) education research. Evidence of the combination of methods in a single research project can be found in the research of Bryman (2006), Mingers (2001) and Symonds and Gorard (2010). When a combination of methods is used differences in terms of research outcomes and in terms of the generation of knowledge is evident in the focus of researchers from different schools of thought. Objective measuring or understanding or participative change, for example may be different objectives of these researchers from different schools of thought.

A brief discussion on research methodology terminology is provided. This is followed by a discussion on research approaches in terms of paradigms. Information is provided on research methods and data collection techniques. Finally, information on research quality, research validation and ethical considerations are presented.

### 3.2. Background

The use of the terms qualitative and quantitative research in research articles are sometimes confusing. The confusion lies in the fact that qualitative and quantitative research is sometimes used to distinguish between research approaches (Bryman, 2006) and sometimes it is used to distinguish between the nature of the data (Myers, 1997). In terms of the distinction between research approaches Goede *et al.* (2013:244) observed the following:

*'Quantitative purists believe that the observer should be objective and separate from the entities that are observed. They should remain emotionally detached and uninvolved. This is in accordance to the positivism paradigm described in the following section. Qualitative purists reject this and argue for idealism, humanism, and hermeneutics. They are characterised by a dislike of detached writing and prefer detailed and rich description (Johnson & Onwuegbuzie, 2004:14-26). This is in accordance with the interpretive paradigm described in the following section.'*

In terms of the group focusing on the nature of the data to distinguish between qualitative and quantitative research (Oates, 2006; Denzin & Lincoln, 2003; Straus & Corbin, 1998; Myers, 1997), Goede *et al.* (2013:244) provide the following distinction:

*'Quantitative research is used to study natural phenomena and include experiments and numerical methods. It is data based on numbers/values. This is the main type of data generated by experiments and are primarily used by positivists, but can also be used by interpretivists or critical researchers. Qualitative research, on the other hand, uses quantitative data, for example interviews, documents, observations and stories, usually to understand and explain social occurrences. The emphasis is on processes and meaning that cannot always be measured in terms of quantity, amount or frequency. It includes words, images, and sound.'*

This study uses the terms qualitative to refer to textual data and quantitative to refer to numerical data. The assumptions regarding the validity of data are dealt with in terms of research paradigms rather than type of data. The next section describes research paradigms, mixed methods, and research quality.

### 3.3. Research paradigms

According to Hughes (1990:11), 'every research tool or procedure is inextricably embedded to particular versions of the world and to knowing that world.' In the past a paradigm was defined as the universal assumptions of theoretical philosophies that determine the way in which research is conducted and concluded (Wessels, 2014:2-3; Mingers & Brocklesby, 1997:490). This implies that the philosophical assumptions we make about our environment and the world we live in and the research methods that we apply are linked. A paradigm is a constructive framework and De Villiers (2005:144) described it as a 'primary point of departure' for research. This construction implies that elements are connected in a logical manner. Goede *et al.* (2013:245) defined a research paradigm as 'a description of a research methodology according to a specific set of assumptions', while Mingers (2001:242) described a paradigm as 'a construct that specifies a general set of philosophical assumptions covering, for example, ontology (what is assumed to exist), epistemology (the nature of valid knowledge), ethics or axiology (what is valued or considered right), and methodology.'

According to Kuhn (1977:94), who made the concept of a paradigm popular, 'a paradigm is a general concept including a group of researchers having a common education and an agreement on examples of high quality research or thinking.' When researchers base their research on shared research paradigms their research practices are committed to the same rules and standards. Research is directed or guided by direct modelling and abstract rules in paradigms. According to Kuhn (1970:94) a paradigm governs a group of researchers and not a subject matter.

Three paradigms widely used in Information Systems (IS) are positivism and, interpretivism (Parther & Remenyi, 2005:78-79; Goede & De Villiers, 2003:209; Bryant, 2002:3446; Fitzgerald & Howcroft, 1998:155; Mingers & Brocklesby, 1997:490) and critical social sciences (Goede *et al.*, 2013:244). Positivism and interpretivism are sometimes referred to as hard and soft research paradigms respectively (Fitzgerald & Howcroft, 1998:155). Wessels (2014:2-8 – 2-9) described two paradigms (Positivism and Interpretivism) on five levels, namely paradigm, ontological, epistemological, methodological, and axiological levels as shown in

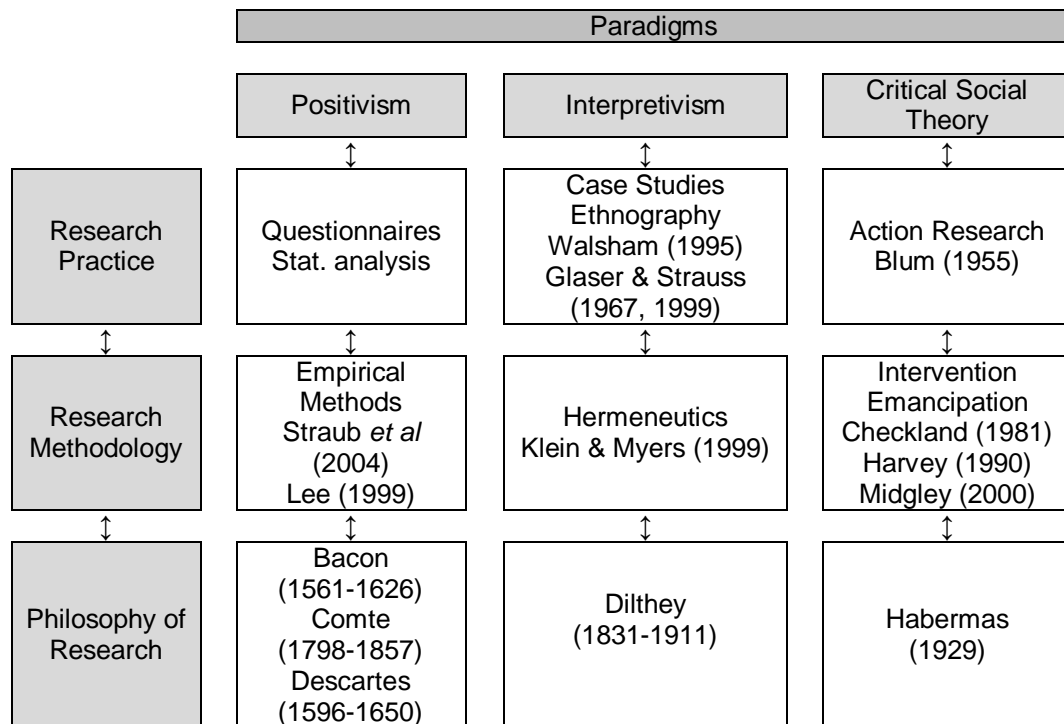
Table 5. Goede *et al.* (2013:246) described the three paradigms (Positivism, Interpretivism and Critical Social Sciences) on three levels, namely the philosophy, methodology and practise level as depicted in Figure 9.

**Table 5: Summary of Soft vs Hard Research Dichotomies (Contrasts)**

(adapted by Wessels, 2014:2-8 – 2-9 from Kroeze, 2012b:62; Fitzgerald & Howcroft, 1998:160)

<b>Paradigm Level</b> A set of theories that is typical of a historical phase in the philosophy of science	
<b>Positivism</b> A belief that the world conforms to fixed laws of causation and that complexity can be tackled by reductionism. Emphasis is placed on objectivity, measurement and repeatability.	<b>Interpretivism</b> A belief that there is no universal truth and that the “truth” is understood and interpreted from the researcher’s own frame of reference. This means that uncommitted neutrality is impossible.
<b>Ontological Level</b> A theory that makes explicit underlying assumptions about reality and the nature of existence.	
<b>Realist</b> A belief that the external world consists of pre-existing hard and tangible structures that exist independently of an individual’s cognition.	<b>Relativist</b> A belief that multiple realities exist as subjective constructs of the mind. Socially transmitted terms direct how reality is perceived and subsequently varies across different languages and cultures.
<b>Epistemological Level</b> A theory which makes explicit the underlying assumptions about understanding the knowledge.	
<b>Objectivist</b> A belief that the researcher remains detached from the research situation. Neutral observation of reality takes place without the contaminating values or influence from the researcher.	<b>Subjectivist</b> There is no distinction between the researcher and research situation. Research findings emerge from the interaction between researcher and research situation. The values and beliefs of the researcher are therefore central mediators.
<b>Etic/Outsider/Objective</b> The research orientation is separate from the researcher, who is seen as being objective.	<b>Emic/Insider/Subjective</b> The research orientation is centred on researcher’s view, with the latter viewed as the best to judge the adequacy of research.
<b>Methodology Level</b> A set of methods and techniques that prescribe the type of research, as well as the associated data collection techniques.	
<b>Quantitative</b> The use of mathematical and statistical techniques to identify facts and causal relationships. Samples can be larger and more representative. Results can be generalised to larger populations with known limits of error.	<b>Qualitative</b> Focuses on determining what things exist rather than how many there are. Thick descriptions are given on the matter that is less structured and more responsive to needs and nature of research situation.
<b>Confirmatory</b> Is concerned with hypothesis testing and	<b>Exploratory</b> Is concerned with patterns in research

theory verification and tends to follow positivist and quantitative research.	data and also to explain and understand them. Provides a basic descriptive foundation that may lead to generation of hypotheses.
<b>Deduction</b> Uses general results to ascribe properties to specific instances. An argument is valid if it is impossible for the conclusions to be false if the premises are true. Also associated with theory verification/falsification and hypothesis testing.	<b>Induction</b> Begins with specific instances that are used to arrive at overall generalisations which can be expected on the balance of probability. New evidence may cause conclusions to be revised. Criticised by many philosophers of science, but plays an important role in theory/hypothesis conception.
<b>Laboratory</b> Precisely measures and controls research variables. However, this is at the expense of naturalness of situation, since real world intensity and variation may not be achievable.	<b>Field</b> Emphasis is placed on the reality of context in natural situation, but precision in control of variables and behaviour measurement cannot be achieved.
<b>Nomothetic</b> Group centred perspective using controlled environments and quantitative methods to establish general laws.	<b>Idiographic</b> Individual-centred perspective that uses naturalistic context and qualitative methods to recognise unique experience of the subject.
<b>Axiological Level</b> A pragmatic theory regarding the study of values in terms of morals and ethical stance.	
<b>Rigor</b> Research characterised by hypothetic-deductive testing according to the positivist paradigm. Emphasis is placed on internal validity through tight experimental control and quantitative techniques.	<b>Relevance</b> The external validity of actual question and its relevance to practice is vital, rather than constraining the focus to “rigorous” methods.



**Figure 9:** Summary of three research paradigms

(Goede *et al.*, 2013:246)

### 3.3.1. Positivism

Several researchers (Kroeze, 2012b:47; Pather & Remenyi, 2005:78-79; Burrell & Morgan, 1979:25) see positivism as the traditional research paradigm used by researchers to direct their research. As a philosophy 'positivism is in accordance with the empiricist view that knowledge stems from human experience. It has an atomistic, ontological view of the world as comprising discrete, observable elements and events that interact in an observable, determined and regular manner' (Collins, 2010:38). The purpose of positivistic research is often to objectively measure the effect of specific variables in a situation (Goede *et al.*, 2013:245). Despite many differences among positivist philosophers, such as Comte and Durkheim, Giddens (1974:2) identified the following claims or perspectives that make up the positivistic philosophy:

- Reality consists in what is available to the senses.

- Science constitutes a framework by which any form of knowledge can be determined.
- The natural and human sciences share common logical and methodological foundations and methods of natural sciences can be applied in social sciences.
- There is a fundamental distinction between fact and value. Science deals with facts, while values belong to an entirely different order of discourse beyond the remit of science.

Positivistic researchers, from an ontological perspective, are realists who believe that the external world is an integrated reality of tangible structures that are precise, objective and value-free (Goede *et al.*, 2013:245; De Villiers, 2005:142; Fitzgerald & Howcroft, 1998:160).

Positivistic researchers, from the epistemological viewpoint, are objectivists and should be neutral, unbiased and detached from the research environment in an effort not to influence results (Kroeze, 2012a:1).

The positivistic researcher, from an axiological perspective, is focused on the systematic recreation of true occurrences from where hypotheses may be tested and confirmed. Quantitative techniques are used in tight experimental controlled environments and internal validity is emphasised.

Positivistic research, from the methodology viewpoint, is conducted in situations where well-organised experiments are executed by examining well-defined and quantifiable environmental variables in a closed system. In a typical research project the researcher will define a hypothesis and identify variables to test the hypothesis. Scientific and statistical methods are used to obtain results that are considered valid if the hypothesis can be emulated repeatedly and consistently using the environmental variables (Goede & De Villiers, 2003:209; Klein & Myers, 1999:69).

### 3.3.2. Interpretivism

Interpretivists, in contrast to positivists, believe that there is no universal truth and people form and assign their own meanings to the world around them and to the behaviour they manifest in that world (Schutz, 1962). The Interpretivists paradigm integrates human interest into the research and researchers have to interpret elements of the study. According to Myers (2008:38) 'interpretive researchers assume that access to reality (given or socially constructed) is only through social constructions such as language, consciousness, shared meanings, and instruments.' Interpretivism is 'associated with the philosophical position of idealism and is used to group together diverse approaches, including social constructionism, phenomenology and hermeneutics; approaches that reject the objectivist view that meaning resides within the world independently of consciousness' (Collins, 2010:38). Moreover, Interpretivism studies usually focus on meaning and may employ multiple methods in order to reflect different aspects of the issue. Hughes (1990:90) stated that 'the method recognises the actions, events and artefacts from within human life; not as the observation of some external reality.' The social context and orientation of the research environment and the social orientation of the researcher influence interpretivism.

Interpretivists, from the ontological viewpoint, believe in multiple realities that are time and context dependent (Wessels, 2014:2-12) and the subjectivity makes it value-driven (De Villiers, 2005:142; Klein & Myers, 1999:69).

According to the epistemology viewpoint no differentiation is made between research environment and the subjective researcher. A social relation is formed in an interactive network between researcher and environment (Goede & De Villiers, 2003:2009) dominated by the values and believes of the researchers (Klein & Myers, 1999:69). Interpretivism in information systems are concerned with the social context of technology, how it is constructed by people and consequently how information technology influence people (Oates, 2009:292). From this social perception all assumptions are epistemological by nature (Wessels, 2014:2-12). This means that knowledge of the world is obtained by observation. On the one side existing knowledge (knowledge that has always been in existence) is discovered by the

researcher and on the other side knowledge is dynamically generated by the researcher's interpretation of observations.

Quality and relevance, from the axiological viewpoint, forms the basis for empirical research of Interpretivism (Fitzgerald & Howcroft, 1998:160). According to Bacon and Fitzgerald (2001:48) hermeneutics play an important fundamental role in interpretive research. An iterative approach is required to understand the interdependent parts of the whole as well as the whole itself – a Hermeneutics principle that the whole is greater than its parts.

The methodology viewpoint allows one to observe the research object in its natural environment in detail without theoretical constructs and predetermined conclusions (Kaplan & Duchon, 1988:572). Data are normally generated by means of empirical studies guided by specific research questions. Research is conducted and data interpreted in the context of social constructs (Pather & Remenyi, 2005:79; Klein & Myers, 1999:67) for example events, concepts and categories that consist of numerous uncontrolled, immeasurable and even unidentified environmental variables (Wessels, 2014:2-14; Kaplan & Duchon, 1988:572). The aim is to provide an explanation of the phenomena by interpreting the data and to understand the derived information (Goede *et al.*, 2013:245). The trustworthiness (reliability) of interpretive research is determined by the natural occurrences of the research outcomes (De Villiers, 2005:142; Fitzgerald & Howcroft, 1998:160).

### **3.3.3. Critical social research**

The Critical Social Theory 'is a school of thought that has as its primary objective as the improvement of the human condition' (Myers & Avison, 2002:116). According to Harvey (1990:1) critical social research is underpinned by a critical dialectical perspective that attempts to dig beneath the surface of historically specific, oppressive and social structures. Critical social research focuses on general theoretical problems, as well as specific investigations of concrete problems of contemporary social organisation (Myers & Avison, 2002:116).

Critical social theorists view knowledge as being structured by existing sets of social relations (class, gender or race) that are oppressive. 'Knowledge is critique... It is a dynamic process not a static entity. It is the process of moving towards the understanding of the world and of the knowledge that structures our perceptions of the world' (Harvey, 1990:3). The aim of critical social research is to emancipate or change suppressive behaviour.

According to Myers and Avison (2002:116) Critical Social Theory was to break with traditional hypothetical deductive methods, which are oriented towards the preservation and gradual reformation of the status quo. Critical Social Theory was intended to be a radically different approach that would take into account the human construction of social forms of life and the possibility of their recreation.

Myers and Avison (2002:116) argued that the primary difference between traditional social theory and Critical Social Theory is the researcher's attitude towards his/her world and work.

### **3.4. Research methods**

#### **3.4.1. Action research**

According to Goede *et al.* (2013:248) action research is used by Critical Social Theory studies as a method to intervene in a problem environment. Researchers using action research often make use of methods from other paradigms to gather and analyse data. Action research is used since the mid-twentieth century by social and medical sciences and is by now a well-established research method (Baskerville, 1999:2). It gained popularity in academic research of information systems towards the end of the 1990s. The literature is imprecise in basic terminology when definitions of action research are discussed. Sometimes the term 'action research' is used to refer to a general class of methods in social analysis and is sometimes used to refer to a specific subclass of methods (Baskerville, 1999:6). According to Blum (1955:1) action research means the analysis of a social problem with the aim to improve the situation. This implies that action research is conducted in two stages. The first stage is a *diagnostic* stage where the problem is analysed and hypotheses are being developed. The second stage is a *therapeutic* stage

where the hypotheses are tested by intentionally focused change experiments, if possible in a social 'life' situation (Blum, 1955:1).

The social science literature can report more precise definitions of action research, but these formulations tend to emphasise action research features based on goals and objectives rather than characteristics based on the process (Baskerville, 1999:6). Hult and Lennung (1980) and Baskerville (1999:6) identified four major features of action research:

- 'Action research aims at an increased understanding of an immediate social situation, with emphasis on the complex and multivariable nature of this social setting in the information systems domain.'
- 'Action research simultaneously assists in practical problem-solving and expands scientific knowledge. This goal extends into two important process characteristics. First, there are highly interpretive assumptions being made about observations; second, the researcher intervenes in the problem setting.'
- 'Action research is performed collaboratively and enhances the competencies of the respective actors. A process of participatory observation is implied by this goal. Enhanced competencies are relative to the previous competencies of the researchers and subjects, and the degree to which this is a goal, and its balance between the actors, will depend upon the settings.'
- 'Action research is primarily applicable for the understanding of change processes in social systems.'

#### 3.4.1.1. ***Forms of action research***

Action research is not a single uniform research method, but rather refers to a class of research approaches. In this class of research methodologies there is some agreement on characteristics that various forms of action research share. These characteristics differentiate action research from other approaches to social research

and according to Baskerville (1999:9) the literature on action research agree on four common characteristics:

- An action and change orientation;
- focus on the problem;
- an 'organic' process involving systematic stages that may be iterative and
- participants collaboratively take part.

As mentioned above action research refers to a class of research approaches and within this class of research approaches there are a variety of different research forms. Researchers have analysed and documented these forms from different angles from an information systems viewpoint. Baskerville and Wood-Harper (1998) identified ten distinctive forms and four distinctive characteristics as shown in **Error! Reference source not found..** It is beyond the scope of this study to describe each of these forms and characteristics.

**Table 6:** Information systems action research forms and characteristics  
(Baskerville, 1999:10)

Forms of IS Action Research	Characteristics of IS Action Research
<ul style="list-style-type: none"> <li>• Canonical</li> <li>• IS Prototyping</li> <li>• Soft Systems Methodology</li> <li>• ETHICS</li> <li>• Multi-view</li> <li>• Action Science</li> <li>• Participant Observation</li> <li>• Action Learning</li> <li>• Clinical Field Work</li> <li>• Process Consultation</li> </ul>	<ul style="list-style-type: none"> <li>• Process Model               <ul style="list-style-type: none"> <li>○ Iterative</li> <li>○ Reflective</li> <li>○ Linear</li> </ul> </li> <li>• Structure               <ul style="list-style-type: none"> <li>○ Rigorous</li> <li>○ Fluid</li> </ul> </li> <li>• Typical Involvement               <ul style="list-style-type: none"> <li>○ Collaborative</li> <li>○ Facilitative</li> <li>○ Expert</li> </ul> </li> <li>• Primary Goals               <ul style="list-style-type: none"> <li>○ Organizational Development</li> <li>○ System design</li> <li>○ Scientific Knowledge</li> <li>○ Training</li> </ul> </li> </ul>

#### 3.4.1.2. ***Domains of action research***

The domain of action research is to understand complex social-organisational problems in an information systems domain where human organisations interact with information systems. The knowledge generated in this process will not only address a specific social setting but will also develop the general theory. 'Action research aims for an understanding of a complex human process rather than prescribing a universal law' (Baskerville, 1999:11).

The domain must exclude settings that will destroy the participative validity of the research, for example where the goals of the researcher and client disagree completely. Goals from both sides must be negotiated and satisfied during the research (Warmington, 1980) and the researcher must add value to those being researched. The domain must be carefully constructed to ensure that an explicit, clear and mutually agreed theoretical framework is the basis for action to ensure that explicit, general learning materialise from the study. According to Baskerville (1999:11) the ideal domain of the action research method is characterised by a social setting where:

- Both researcher and organisation benefit and the researcher is actively involved.
- The research is based on an explicit, clear conceptual framework. Participants are actively involved and wish to utilise any new knowledge that can be applied immediately.
- The research is a (typical cyclical) process linking theory and practise.

#### 3.4.1.3. ***The action research approach***

Action research is described by Susman and Evered (1978) as a five phase cyclic process as depicted in Figure 10. At first a research environment or a client-system infrastructure must be established. In this identified environment five identifiable

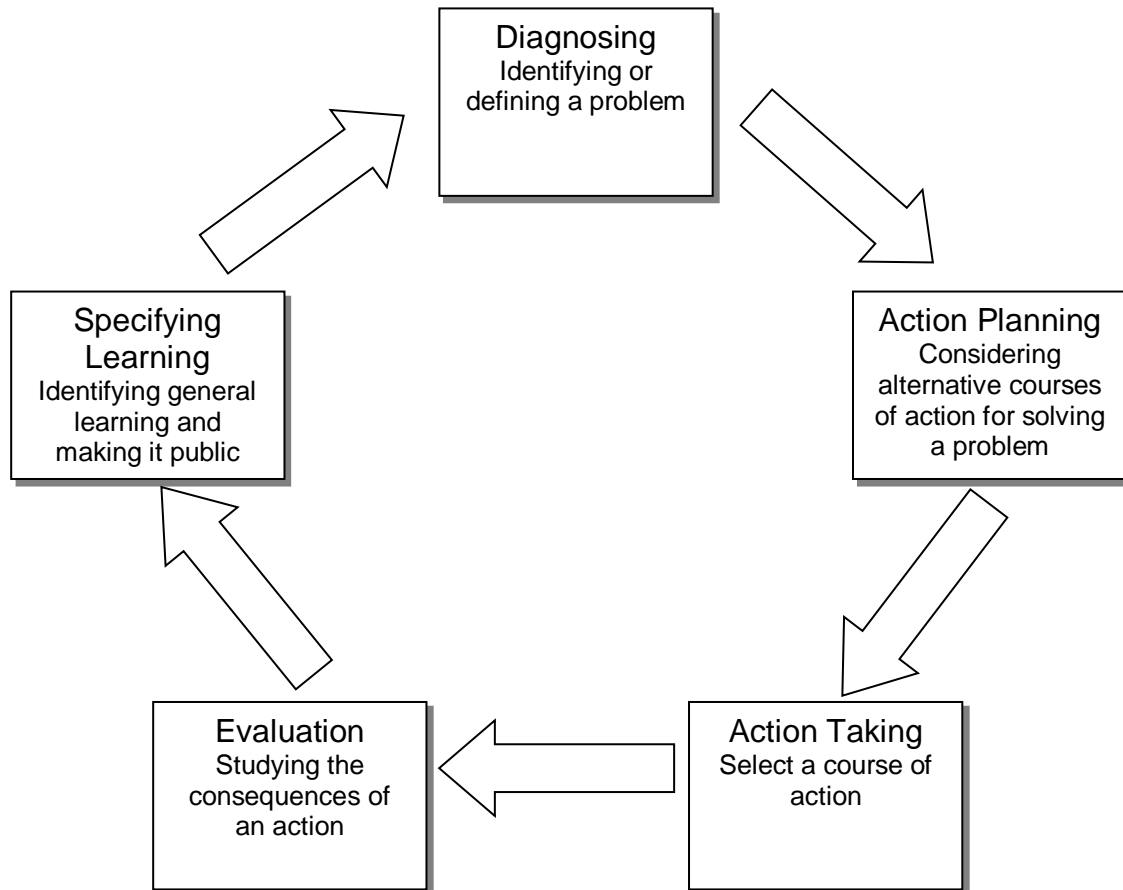
phases are repeated: diagnosing, action planning, action taking, evaluating and specifying learning.

### *Client-system infrastructure*

The client-system infrastructure is the specification and agreement that constitutes the research environment. This infrastructure provides the authority under which researchers and practitioners may specify actions, legitimate actions that will prove beneficial to the client or host organisation and should also define mutual responsibilities of the client and the researchers to one another. A key aspect of the infrastructure is the collaborative nature of the undertaking.

### *Diagnosing*

During the diagnosing phase primary problems are identified that are the main reasons for the organisation's desire to change. A diagnosis of a holistic view of the complex organisational problem will develop certain theoretical assumptions about the nature of the organisation and the problem domain.



**Figure 10:** Phases within an action research cycle  
(Susman & Evered, 1978:588)

### *Action planning*

Action planning requires the collaboration between researchers and practitioners. Organisational actions are specified that should solve or at least alleviate the primary problems. The planned actions must be steered by the theoretical framework and indicate a future state for the organisation as well as the changes that would realise such a state.

### *Action taking*

The actions identified during the action planning phase are implemented during the action taking phase. Active intervention into the client organisation is a collaborative process by researchers and practitioners. Different interventions can be followed, for

example a directive approach in which the research 'directs' the change, or non-directive, in which the change is applied indirectly.

### *Evaluating*

In this phase the outcomes are evaluated after the actions are completed. This includes determining whether the theoretical implementation of the action was realised and whether the problems were solved by these effects. If the desired changes were unsuccessful the next iteration of the action research cycle should establish a framework for correcting the situation.

### *Specifying learning*

This phase is usually an on-going process although it is formally undertaken lastly. Three audiences benefit from the knowledge gained by the action research (Baskerville, 1999:16) namely:

- 'The restructuring of organisational norms to reflect the new knowledge gained by the organisation during the research.'
- 'Where the change was unsuccessful the additional knowledge may provide foundations for diagnosing in preparation for further action research interventions.'
- 'The success or failure of the theoretical framework provides important knowledge to the scientific community for dealing with future research settings.'

## **3.5. Data collection techniques**

### **3.5.1. Observation**

Observation involves the systematic observation, recoding, description analysis and interpretation of people's behaviour (Saunders *et al.*, 2009:288). There are two main types of observation namely participant observation and structured observation. Participant observation is when the researcher attempts to participate fully in lives

and activities of the participant and by doing so become part of the group, organisation or community (Saunders *et al.*, 2009:289-290). According to Gill and Johnson (2002:144) this enables the researcher to share the experiences by not only observing but also experiencing it emotionally. The purpose of a participant observation is to discover the meanings people attach to their actions. The role of a structured observer is more detached and the purpose of a structured observation is to tell how often things happen rather than why they happen (Saunders *et al.*, 2009:300).

### **3.5.2. Interviews**

According to Kahn and Cannell 1957 (cited by Saunders *et al.*, 2009:318) an interview is a purposeful discussion between two or more people. Interviews can help gather data that are valid, reliable and relevant to research questions and objectives (Saunders *et al.*, 2009:318). Structured interviews, semi-structured interviews and unstructured or in-depth interviews are the different forms of interviews available. Structured interviews use questionnaires that are the same for all participants. Semi-structured interviews are interviews where the researcher has a list of themes and questions that need to be covered, but the flow and order of these questions can vary from participant to participant. Unstructured interviews are used to explore a general area in which researchers are interested in, in depth. Unstructured interviews are informal.

### **3.5.3. Questionnaires**

According to Saunders *et al.* (2009:360) questionnaires refer to all techniques of data collection where every participant is asked to respond to the same set of questions. Structured interviews and telephone interviews as well as those questionnaires where the interviewer are not present, can all be regarded as questionnaires. Saunders *et al.* (2009:362) provide the following list of guidelines that maximises the response rate, validity and reliability of a questionnaire:

- Careful design of individual questions.
- Clear and pleasing layout of the questions.
- Lucid explanation of the purpose of the questionnaire.
- Pilot testing.
- Carefully planned and executed administration.

According to Saunders *et al.* (2009:362) questionnaires are not particularly good for research that requires a large number of open-ended questions, but they do work well for standardised questions that can be interpreted in the same way by all participants. Questionnaires are therefore more commonly used in descriptive or explanatory research. Questionnaires can be administered in many different ways including Internet, intranet, postal, telephone as well as delivery and collection.

#### **3.5.4. Mixed methods**

In 1959 the concept of mixed methods approach began when Campbell and Fisk used multi-methods to study psychological traits. Other researchers were encouraged to use their multi-method matrix to look at various data collection techniques. Soon qualitative methods such as observation and interviews were used together with quantitative methods like traditional surveys (Sieber, 1973:1335-1359). Researchers soon believed that biases inherent in one method of data collection could be reduced by another in this way. Triangulation was born. Researchers could use both qualitative and quantitative methods of data collection and then compare the results to see if the findings are the same, providing a means of convergence (Jick, 1979:602). Jonson *et al* (2007:118) performed a study in which they sought to formalise a definition by synthesising perspectives of thirty one leaders in the field. They concluded that:

*'Mixed methods research is the type of research in which a researcher or team of researchers combine elements of qualitative and quantitative research approaches (e.g. use of qualitative and quantitative viewpoints, data*

*collection, analysis, inference techniques) for the broad purpose of breadth and depth of understanding and corroboration.'*

Mingers (2001:241) argued that different methods applied from different paradigms will provide a thorough understanding of different aspects of reality. Mingers (2001:243-244) further argued that multi-method research is necessary because different methods focus on different aspects of a situation and that a research study is a process that would typically proceed through a number of phases, each phase requiring a different research approach. Teddlie and Tashakkori (cited by Goede *et al.*, 2013:249) discussed three advantages of using mixed methods in a project namely triangulation (the validation of research results by combining different data sources, research methods and research practitioners); creativity (results from one study can reveal new aspects that require more research); and expansion (extend the range of inquiry by using mixed methods).

#### 3.5.4.1. ***Designing and conducting mixed method research***

One of the key principles according to Creswell and Plano Clark (2011:61) of conducting mixed method research is to identify reasons for mixing quantitative and qualitative methods. Creswell and Plano Clark (2011:62) provided a table that summarises several reasons for conducting mixed method research as presented in Table 7.

**Table 7:** Two typologies of reasons for mixing methods

(Creswell & Plano Clark 2011:62)

<b>Greene, Caracelli and Graham (1989)</b>	<b>Bryman (2006)</b>
<ul style="list-style-type: none"> <li>• <b>Triangulation</b> seeks convergence, corroboration, and correspondence of results from the different methods.</li> <li>• <b>Complementarity</b> seeks elaboration, enhancement, illustration, and clarification of the results from one method with the results from the other method.</li> <li>• <b>Development</b> seeks to use the results from one method to help develop or inform the other method, where development is broadly</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Triangulation or greater validity</b> refers to the traditional view that quantitative and qualitative research might be combined to triangulate findings in order that they may be mutually corroborated.</li> <li>• <b>Offset</b> refers to the suggestion that the research methods associated with both quantitative and qualitative research have their own strengths and weaknesses so that combining them allows the researcher to offset</li> </ul>

<p>constructed to include sampling and implementation, as well as measurement decisions.</p> <ul style="list-style-type: none"> <li>• <b>Initiation</b> seeks the discovery of paradox and contradiction, new perspectives of frameworks, the recasting of questions or results from one method with questions or results from the other method.</li> <li>• <b>Expansion</b> seeks to extend the breadth and range of inquiry by using different methods for different inquiry components.</li> </ul>	<p>their weaknesses to draw on the strengths of both.</p> <ul style="list-style-type: none"> <li>• <b>Completeness</b> refers to the notion that the researcher can bring together a more comprehensive account of the area of inquiry in which he or she is interested if both quantitative and qualitative research is employed.</li> <li>• <b>Process</b> refers to when quantitative research provides an account of structures in social life but qualitative research provides sense of process.</li> <li>• <b>Different research questions</b> refer to the argument that quantitative and qualitative research can each answer different research questions.</li> <li>• <b>Explanation</b> refers to when one is used to help explain findings generated by the other.</li> <li>• <b>Unexpected results</b> refer to the suggestion that quantitative and qualitative research can be fruitfully combined when one generates surprising results that can be understood by employing the other.</li> <li>• <b>Instrument development</b> refers to contexts in which qualitative research is employed to develop questionnaire and scale items—for example, so that better wording or more comprehensive closed answers can be generated.</li> <li>• <b>Sampling</b> refers to situations in which one approach is used to facilitate the sampling of respondents or cases.</li> <li>• <b>Credibility</b> refers to suggestions that employing both approaches enhances the integrity of findings.</li> <li>• <b>Context</b> refers to cases in which the combination is rationalised in terms of qualitative research providing contextual understanding coupled with either generalizable, externally valid findings or broad relationships among variables uncovered through a survey.</li> </ul>
---	---

Creswell and Plano Clark (2011:64) further identified four key decisions that are involved when choosing an appropriate mixed method design:

- Level of iteration between quantitative and qualitative techniques. The level of interaction according to Creswell and Plano Clark (2011:64) is the extent to

which they are kept independent from one another. Greene (2007:120) argues that this decision is the most important and critical when designing a mixed method study. Greene (2007) noted two general options for a relationship namely: independent and interactive.

- On an independent level the quantitative and qualitative techniques are implemented so that they are independent. Quantitative and qualitative research questions, data collection, and data analysis techniques are kept separate.
  - On an interactive level a direct interaction exist between the quantitative and qualitative techniques. The two methods are mixed through this interaction before the final interpretation. Interaction can occur in many different ways in different points of the research process.
- The relative priority of the quantitative and qualitative techniques. The priority or importance of the quantitative and qualitative techniques within the design need to be established. According to Creswell and Plano Clark (2011:65) there are three possible weighting options for a mixed method design:
    - In the case of equal priority both quantitative and qualitative techniques are equally important in addressing the research problem.
    - In the case of quantitative priority a greater emphasis falls on the quantitative techniques used and the qualitative techniques are used in a secondary role.
    - In the case of qualitative priority when a greater emphasis falls on the qualitative techniques used and the quantitative techniques are used in a secondary role.
- The timing of the quantitative and qualitative techniques. Timing is also an important decision researchers have to make and it refers to the temporal relationship between the different techniques. This can be referred to in relation to the time data sets are collected or most importantly the order in which the researcher uses the results from the two sets of data.

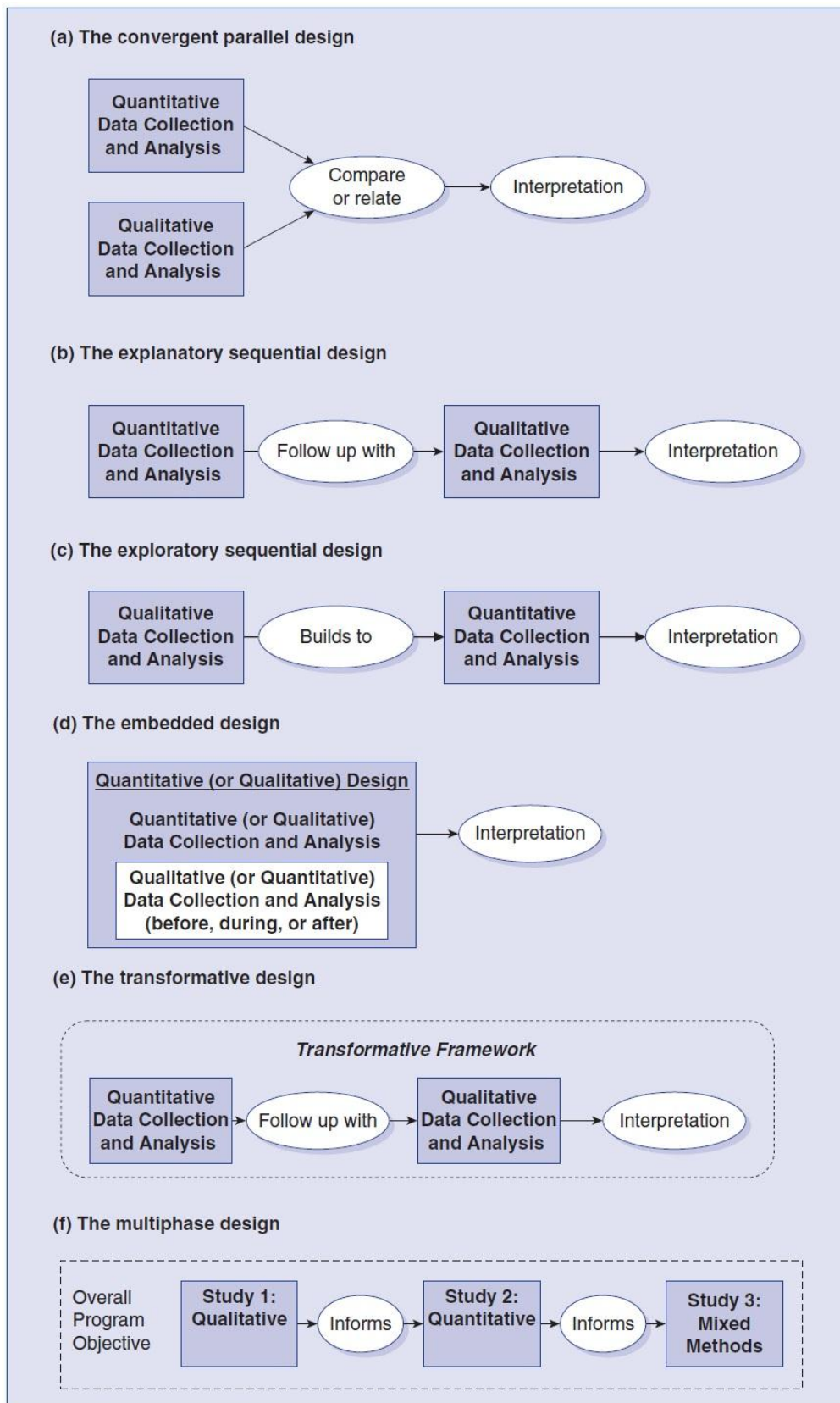
- Concurrent timing occurs when both quantitative and qualitative techniques are implemented during a single phase.
  - Sequential timing occurs when the collection and analysis of techniques are implemented in separate phases.
  - Multiphase combination timing occurs when sequential and/or concurrent timing is implemented in multiple phases during the study.
- The procedure for mixing quantitative and qualitative techniques according to Creswell and Plano Clark (2011:66) is the explicit interrelation of the quantitative and qualitative techniques used in the study. It is the process of combining and integrating the different methods. Creswell and Plano Clark (2011:66) have identified four possible points during a study where mixing can take place.
    - Mixing during interpretation occurs when quantitative and qualitative techniques are mixed during the final step. This is when the researcher draws conclusions or inferences that reflect the combination of results from both the quantitative and qualitative techniques.
    - Mixing during data analysis occurs when quantitative and qualitative techniques are mixed during the analysis stage of the research. After analysing the two sets of data separately the researcher uses an interactive strategy of merging to bring the two sets of results together in a combined analysis.
    - Mixing during data collection occurs when quantitative and qualitative techniques are mixed during the data collection stage when the second set of data is collected. The researcher uses a technique of connecting the results of one technique to build on the results of the other.
    - Mixing at the level of design occurs when quantitative and qualitative techniques are mixed during the design stage of the study. This type of mixing can involve mixing within the traditional quantitative and qualitative research design. Three strategies for mixing during the

design stage are: embedded mixing, theoretical framework-based mixing, and program objective framework-based mixing.

#### 3.5.4.2. ***Major mixed method designs***

Using the questions discussed in the previous subsection a researcher finds the mixed method design that reflects interaction, priority, timing and mixing. Creswell and Plano Clark (2011:68) recommended six major mixed method designs that provide a useful framework for researchers working to design their own studies. The six mixed methods designs are the convergent parallel design, the explanatory sequential design, the exploratory sequential design, the embedded design, transformative design and the multiphase design. Figure 11 portrays the six designs recommended by Creswell and Plano Clark (2011:68-69).

- The convergent parallel design. The convergent parallel design is when quantitative and qualitative data are collected at the same time, during the same phase of the research process.
- The explanatory sequential design. The explanatory sequential design occurs in two phases that are distinct and interactive. First quantitative data are collected and analysed to answer the study question then based on the quantitative data, qualitative data are collected for an explanatory purpose.
- The exploratory sequential design. The exploratory sequential design also uses sequential timing but start by collecting qualitative data for the exploratory phase and then uses quantitative data in order to test or generalise the initial findings.



**Figure 11** : Six major mixed methods research design  
(Creswell & Plano Clark 2011:69)

- The embedded design. The embedded design occurs when both qualitative and quantitative data are collected at the same time within a traditional quantitative or qualitative design.
- The transformative design. The transformative design is shaped within a transformative theoretical framework. The overarching theoretical perspective determines the interaction, priority, timing and mixing.
- The multiphase design. The multiphase design combines sequential and concurrent methods over a period of time in a study addressing an overall program objective. Program evaluation often uses the multiphase design where quantitative and qualitative approaches are used over time to support the development, adapting and evaluation of a specific program.

### **3.6. Quality criteria for research**

According to Goede *et al.* (2013:250) the concepts of reliability and validity were traditionally the key tools for quality assessment when doing research. However there are many writers who claim that these tools are no longer meaningful because of their lack of semantic rigour in non-positivistic research. Heikkinen *et al.* (2007:7) argued that methodologists have introduced tens of alternative concepts and views without coherence and this can cause confusion about the diversity of alternatives. Quality and quality criteria issues have become more important when discussing methodological matters. According to Bryman *et al.* (2008:262) the rise of qualitative research over the last 25-30 years is one of the reasons for the growing interest in quality criteria. The criteria for positivistic research are well-known and agreed on, but it is not the case for interpretive and critical social theory research.

The quality of a positivistic research project can be determined with specific measure. The suitability of a positivistic research project can be evaluated with a set of aspects in order to justify its suitability for academic publication. Criteria that apply to positivistic research include the following (Guba & Lincoln, 1989:233-235):

- Internal validity: The extent to which variations in a dependable variable can be attributed to controlled variation in an independent variable.
- External validity: Inference that the presumed casual relationship can be generalised across alternative measures of cause and effect.
- Reliability: Consistency of a given inquiry involving predictability, dependability and/or accuracy and replicability.
- Objectivity: Neutrality and freedom from bias.

Guba and Lincoln (1989:236-243) argued that the conventional positivistic criteria can be adjusted to be meaningful for the constructivist (interpretive) inquiry as follows:

- Credibility: Credibility is parallel with internal validity. The focus is on establishing a match between constructed realities by respondents rather than presumed reality.
- Transferability: Transferability is parallel with external validity. The positivistic paradigm requires both sending and receiving contexts to be random samples of the same population. This is replaced with an empirical process for checking the degree of similarities between sending and receiving contexts within the interpretive paradigm.
- Dependability: This may be thought of as parallel to reliability. The main concern is the stability of data over time.
- Confirmability: This is parallel with objectivity. Assuring that data, interpretations and outcomes are rooted in context is its main concern. The assurance of integrity of an interpretive paradigm lies within the data itself. Data can be tracked to its source so that bias can be kept in check.

The following five principles are presented by Heikkinen *et al.* (2007:8-9) for the evaluation of action research as narrative:

- Principle of historical continuity: Awareness is emphasised on the socio-historical frame of the research project.
- Principle of reflexivity: Ontological presumptions as well as the epistemological analysis are included and researchers must consciously reflect on insights. The research must also be transparent, meaning that the material and methods must be described.
- Principle of dialectics: Different voices must be combined as authentically as possible.
- Principle of evocativeness: The extent to which the research evokes mental images, bringing back memories or emotions related to the theme.

According to Bryman (2006:122) one of three approaches can be used to evaluate quality when combining methods in one project as in the case of mixed method research:

- Convergent criteria: Using the same criteria for both the positivistic and the interpretive phases of the study.
- Separate criteria: Use separate criteria for the interpretive and positivistic phases of the research.
- Bespoke criteria: Where new criteria are devised specifically for mixed methods research projects.

According to Bryman (2006:124) the outcomes of a mixed method research study are often unplanned and generally usable criteria is difficult to develop. Researchers are in favour of mixed methods, Bryman (2006:111-126) and Feilzer

(2010) advocate the use of a pragmatic approach when determining the value of research. The importance of the research question is stressed by Bryman (2006:118) and according to Goede *et al.* (2013:251) the answering of the research question should be used as the measure. Different criteria could be used for different components of a mixed method research. A study by Bryman *et al.* (2008:261-276) brought forward a number of criteria. The more important criteria are as follows:

- **Relevance:** Relevance to the research question.
- **Transparency:** It is important for researchers to be transparent (when using mixed methods) about the nature and content of the procedures used.
- **Integration:** The different components of a mixed method must be integrated.
- **Rationale:** Researchers should be clear about their grounds for using mixed method approaches.

### **3.7. Research validation**

In general validity refers to 'the condition of being true' according to Locke *et al.* (2010:81). Research validity indicates the truthfulness of the results. The integrity of a study may be influenced by aspects such as data collection methods and measuring instruments. To ensure the validity of questions, the research should identify the best set of questions to obtain data for each variable (Fowler, 2009:112). Many questions of the same subjective state put in different ways are combined into a scale that is beneficial to even out extreme responses and improve the validity of the process (Fowler, 2009:111).

### **3.8. Ethical consideration**

Permission has been obtained from the two universities to conduct this study and involve the educators. The following ethical principles are adhered to as recommended by the International Development Research Centre (2011).

The individuals who participated by completing the questionnaire were informed of the aims, methods and anticipated benefits of this study. Participants were asked to participate out of free will and were aware that they may decide not to participate any further if they wish to do so. All participants were informed that the data will only be used in a summarised way and treated as confidential at all times.

### **3.9. Conclusion**

The aim of this chapter was to gain an understanding of research methodologies. Information was provided on three research paradigms, Positivism, Interpretivism and Critical Social Research. Action research as a research methodology was described. The chapter concluded with a discussion on data collection techniques, quality criteria for research, research validation and ethical considerations.

## **CHAPTER FOUR: THE RESEARCH STRATEGY AND ANALYSIS**

### **4.1. Introduction**

The purpose of the chapter is to report on the empirical process followed in this study. The literature was consulted and a problem was recognised. The problem was identified as: the diversity and complexity of digital games makes it difficult to decide on a strategy and approach to select serious games for the Computer Science class (Kadle, 2009:5). The problem statement for this study was therefore formulated as a need by educators for a model or framework to help in the selection process of serious games for the Computer Science class.

The purpose of this study was to identify a suitable model or framework to select serious games for the Computer Science class. A literature study revealed existing models or frameworks that can assist in the selection of serious games for educational purposes. The two models, a framework and a project namely the four-dimensional framework, the RETAIN model, the Magic Bullet model, and the Levee Patroller project, were identified and discussed in Chapter 2. The rest of this chapter reports on the research process that was followed to execute the research.

### **4.2. Research strategy**

The research problem described from a philosophical view is in line with the critical social research paradigm as the critical social researcher attempts to get to the bottom of a problem (Harvey, 1990) and identify and resolve oppressing structures in a problem situation (Goede *et al.*, 2013:247). The premise of this study was that the educator wants to use serious games in class but the selection of an appropriate serious game seems to be a problem. The researcher wanted to resolve the problem by introducing game selection models or frameworks to the educator. The cyclic process of action research seemed to be the best practice to solve this problem.

Action research, the research practice within the Critical Social Theory paradigm, is an iterative research methodology for navigating change in a problem situation and is based on an explicit, clear conceptual framework. Action research attempts to increase the understanding of an immediate problem situation while simultaneously assisting with a practical solution in an attempt to solve the problem and expand scientific knowledge. It is a collaborative process that improves the competencies of both researcher and participants and is primarily applicable for the understanding of change processes where participants wish to utilise any new knowledge that can be immediately applied (Baskerville, 1999:6).

Action research link theory and practice in a five phase cyclic process as indicated in Figure 10 (Chapter 3 section 3.4.1.3). At first the client-system infrastructure must be established (Susman & Evered, 1978:588). In this identified environment five recognisable phases are repeated: diagnosing, action planning, action taking, evaluating and specifying learning. The next section describes these action research phases and how the phases were implemented in this research.

#### **4.2.1. Research environment**

The research environment is constituted by specifications and agreements between the researcher and participants and this research environment is labelled the client-system infrastructure by Susman and Evered (1978:589). This infrastructure may specify legitimate actions that will prove to be for the benefit of the client. The mutual responsibilities of the client and the researcher to one another should also be specified. A key element of the infrastructure is the collaborative nature of the task on hand (Susman & Evered, 1978:589). This study involved all educators lecturing Computer Science at two university campuses in the Gauteng province of South Africa as explained in Chapter 1. During one-on-one discussions both telephonically and in person, their possible involvement in this study and the aim of the study was explained. The fact that this study did use action research as research methodology was illuminated. The different phases of the action research cycle were outlined as well as what was expected from participants within each phase. After these discussions eighteen educators agreed to participate in this study.

After the research environment was set the next step was to initiate the different phases of action research.

### **4.3. Action research: first cycle**

As mentioned above action research is a cyclic process. This section describes the first of two cycles that was completed in this research.

#### **4.3.1. Diagnosing: first cycle**

The reasons for an organisation's desire to change may be caused by certain primary problems. These principle problems are identified during the diagnosing phase of the action research cycle. Theoretical assumptions about the nature of the organisation and the problem domain will be developed when the problem is examined in a holistic view (Susman & Evered, 1978:590). In the context of this study a literature research revealed a problem that lead to the problem statement of this study: a need by educators for a model or framework to help in the selection process of serious games for the Computer Science class. In order to determine whether this was indeed a problem to educators in Computer Science, data were collected to investigate the views of participants who participated in this study. A questionnaire was used and the items in the questionnaire were grouped under five main categories: perceived usefulness of serious games, attitude towards the use of serious games, intention to use serious games, perceived ease of use of serious games and additional factors concerning the use of serious games. Eighteen questionnaires were administrated and responses from all eighteen educators were received. Responses to the items in the questionnaire are described next.

#### 4.3.1.1. *Analysis of the data*

Data from the questionnaires were captured and analysed. The data revealed the educators' perceptions of serious games in class.

- *Perceived usefulness of serious games.* Participants were very positive when they commented on how they perceive the usefulness of serious games. With a score of 82,4 percent participants felt that playing games are useful, and 73,7 percent agreed that games have educational value while 84,2 percent indicated that games can enhance lecturing. Games may teach students more in a shorter time as agreed by 73,7 percent of the participants, learning abilities may increase as indicated by 68,4 percent and 94,7 percent agreed that games improve learning performance.
- *Attitude towards the use of serious games.* Coursework is more interesting as indicated by 84,2 percent of the participants while 84,2 percent believe that it is a good idea to incorporate games into coursework. It was also agreed by 78,9 percent of the participants that they liked the idea of using games in their lectures.
- *Intention to use serious games.* The majority of the participants (84,2%) indicated that they will frequently use games as needed, while only 26,3 percent responded that they will use games if it is expected from them. Up to 68,4 percent would use games in as many modules as possible and 63,2 percent expected that if they use games in one module their intention to expand the use of games to other modules will grow. There is a concern among participants as 78,9 percent reported that they will only use games if they are convinced that students will benefit from it.
- *Perceived ease of use of games.* Participants were asked to comment on the interface of their most favourite game. The majority (84,7 %) found the interface easy to learn, (93,3 %) found it easy to become skilful with the interface, (100 %) found the interface flexible to interact with and (93,3 %) found the interface clear and easy to understand.

- *Additional factors concerning the use of games.* Participants were prompted to respond to a few general questions concerning the use of games in class. They were not sure about more or less contact time in class as 47,4 percent indicated that they would prefer more contact time rather than using serious games as part of a module. The majority (84,2%) felt that students should not pay for using serious games, and 57,9 percent would use serious games as long as they do not have to develop them. When asked whether there is enough time to deploy serious games in class 68,4 percent responded in favour, while 84,2 percent indicated that their facilities are inadequate to host serious games. Participants also agreed (68,4 %) that it would take more time and effort to incorporate serious games in class and 73,7 percent remarked that the current curricula do not support the use of serious games. Finally 57,9 percent indicated that it will be very difficult to find a useful serious game for their specific module.

In the final observation participants indicated that it will be very difficult to select a useful serious game for a specific module in Computer Science. The primary problem was identified and the theoretical assumption was made that it will be difficult to select a serious game for the Computer Science class. This is in line with the problem statement and objective of this study and the action planning phase of the action research cycle was initiated.

#### **4.3.2. Action planning: first cycle**

The information gathered during the initial phase of the action research cycle revealed that participants are in favour of using serious games in class and are convinced about the benefits of using serious games in class. There was a concern about finding a useful serious game for use in class. This, linked with the objective of this study, lead to the actions taken in the planning and implementation phase of the action research cycle.

According to Susman and Evered (1978:589) action planning require cooperation between researcher and participants. At this stage it was decided collaboratively by the researcher and the participants that participants were to evaluate the models and the framework discussed in Chapter 2, namely the four-dimensional framework, the RETAIN model and the Magic Bullet model, and to report on the suitability of these models or the framework for selecting serious games for the Computer Science class. The fourth model discussed in Chapter 2, the Levee Patroller project was not included as all the features of the Levee Patroller project are contained within the RETAIN model and the four-dimensional framework.

Action planning should be steered by a theoretical framework (Susman & Evered, 1978:590). A checklist for the four-dimensional framework, the RETAIN model and the Magic Bullet model were provided to participants in the form of tables that briefly describe the different components of each of the models and framework to enable participants to evaluate the models and framework. Where possible, an example was provided of how the models and framework were used by other researchers to evaluate serious games.

#### **4.3.2.1. *Check list for the four-dimensional framework***

The four-dimensional framework requires the educator to consider four main dimensions (context, learner specification, pedagogic considerations and mode of representation) in advance of using games and/or simulations in their practice. 'The four-dimensional framework should be regarded as iterative and reflects the processes of evaluation that the educator will undertake in advance of game or simulation selection and use. The framework aims to provide a touchstone for consideration rather than a prescriptive approach, allowing educators to be more critical about how they embed games and/or simulations into their lesson plans' (de Freitas & Oliver, 2006:257). Table 8 represents an expanded checklist (see Table 3) for the four dimensions in the four-dimensional framework.

**Table 8:** Checklist for the four-dimensional framework

<b>Four-dimensional framework</b>
<b>Checklist for evaluating the use of educational games and simulations</b>
<b>Context (environment, access to learning, supporting resources)</b>
Context that covers where the learning occurs, ranges from the macro level, that is historical, political and economic factors (for example, are you playing because it is a school directive?), to the micro level (for example the educator's background and experience, cost of game licenses) etc.
<i>'The context dimension defines the place where learning takes place, e.g. in a school or a work environment, as this can affect the disciplinary context, particularly where the learning is conceptual or applied'</i> (Goulding <i>et al.</i> , 2012:105).
What is the context for learning? (e.g. school, university, home, a combination of several)
Does the context affect learning? (e.g. level of resources, accessibility, and technical support)
How can links be made between context and practice?
<b>Learner specification (profile, role, competencies)</b>
Learner specification, for the individual learner or the group, requires the educator to consider the learners' preferred learning style and previous knowledge and what methods would best support them given their differing needs.
<i>'The learner's dimension involves a process of profiling and modelling learners and their characteristics in order to ensure there is a match between the learning activities and the required learning outcomes'</i> (Goulding <i>et al.</i> , 2012:105).
Who is the Learner?
What is their background and learning history?
What are the learning styles/preferences?
Who is the learner group?
How can the learner or learner group be best supported?
In what ways are the groups working together (e.g. singly, partially in groups) and what collaborative approaches could support this?
<b>Pedagogic (educational, academic) considerations (associative, cognitive, social/situative)</b>
Pedagogic principles (for example, associative, cognitive, and situative) require the educator to reflect on the learning models and frameworks that enables them to produce appropriate lesson plans.
<i>'The pedagogy dimension analyses the pedagogic perspective of the learning activities, and considers the learning and teaching modes/styles and the methods used for supporting the learning process'</i> (Goulding <i>et al.</i> , 2012:105).
Which pedagogic models and approaches are being used?
Which pedagogic models and approaches might be most affective?
What are the curricula objectives? (list them)
What are the learning outcomes?
What are the learning activities?
How can the learning activities and outcomes be achieved through specially developed software (e.g. embedding into lesson plans)?
How can briefing/debriefing be used to reinforce learning outcomes?
<b>Mode of representation (tools for use) (fidelity, interactivity, immersion)</b>
Mode of representation (how high the levels of fidelity need to be, how interactive the game is, and how immersive the game may be). The representation also covers diegesis (diegesis is a term used frequently in film studies and means the world within the narrative film or the 'story world'), the separation of the immersion aspect with the reflection around the process of playing the game. Most importantly it highlights the potential of briefing and debriefing to reinforce the learning outcomes.

*'The representation dimension outlines the interactive learning experience, such as immersion, fidelity and level of interactivity which affects the level of engagement and motivation' (Goulding et al., 2012:105).*

Which software tools or content would best support the learning activities?
What level of fidelity needs to be used to support learning activities and outcomes?
What level of immersion is needed to support learning outcomes?
What level of realism is needed to achieve learning objectives?
How can links be made between the world of the game/simulation and reflection upon learning?

As an example of the implementation of the four-dimensional framework, Table 9 shows the outcome of the evaluation of a serious game called MediaStage by de Freitas and Oliver (2006:259).

**Table 9:** Outcome of the evaluation of MediaStage using the four-dimensional framework

(de Freitas & Oliver, 2006:259).

<b>Context</b>	<b>Learner specification</b>	<b>Pedagogic considerations</b>	<b>Mode of representation (tools for use)</b>
<p>School-based learning in Media Studies</p> <p>Classroom-based Interactions with the software</p> <p>MediaStage tool supports GCSE Media Studies curriculum</p>	<p>School learners 14–16 year olds are currently using this tool</p> <p>The tool is used primarily for GCSE level but can be used by other ages and in informal settings</p> <p>The tool can be used by learners working singly and in groups</p> <p>Range of differentiated learners with different learning styles can be catered for through the use of this tool as each learner or learner group can engage with the resource according to their own preferences</p>	<p>Use of theories such as Kolb's Experiential Learning (1984) where learners learn from experience through abstract conceptualisation and application in practice</p> <p>Learning outcomes: Conversancy with film craft and approaches allowing the student to experience the process of film and stage craft first hand</p> <p>Learning activities: The student learns through activities based upon directing a play/film</p> <p>Briefing/debriefing: pre-class preparation and post activity reflection and consideration</p> <p>Simulation embedded as a practical session into the lesson plan of the tutor. Individuals</p>	<p>MediaStage uses a medium level of fidelity based upon the use of 3D animated characters</p> <p>MediaStage uses a high level of interactivity between the media world and the learners' own experiences and knowledge, allowing the student to develop an increasing conversancy with the rules and functionality of the simulation tool</p> <p>Learning activities and outcomes achieved through specially developed software supporting an increased awareness of the learner of the processes of stagecraft and film making through increased usage</p>

		will need different levels of attention from the tutor at different stages of the learning process	
--	--	--	--

#### 4.3.2.2. Checklist for the RETAIN model

The purpose of the RETAIN model is to assess how well serious games contain and incorporate academic content (Ulicsak & Wright, 2010:58). Table 10 represents a checklist for the variables in the RETAIN model.

**Table 10:** Checklist for the RETAIN model

<b>RETAIN model</b>				
<b>Checklist for evaluating the use of educational games and simulations</b>				
<b>Relevance (1)</b>	<i>'presenting materials in a way relevant to learners, their needs, and their learning styles, and ensuring the instructional units are relevant to one another so that the elements link together and build upon previous work'</i> Ulicsak and Wright (2010:59).			
	<b>Level 0</b> The story/fantasy creates little stimulus for learning and is in a format that neither is of little interest to the players/learners nor does it utilise advanced organisers.  The player/learner does not know the state of the game or the required learning content based on the choices presented.	<b>Level 1</b> The story/fantasy is age/content appropriate or it has a limited educational focus and little progression.  The pedagogic elements are somewhat defined but occasionally players/learners are allowed by the embedded fantasy to become engaged in inappropriate content or contexts.	<b>Level 2</b> In addition to overcoming limitations and/or adding to Level 1 features, the following are also present:  Specific didactic content is targeted and learning objectives are clearly defined.  Creates interest in what is to be learned and a natural stimulus and desire to learn more.	<b>Level 3</b> In addition to overcoming limitations and/or adding to Level 1 & 2 features, the following are also present:  Is relevant to players'/learners' lives, (real or imagined) and/or the world around them using characters and themes familiar to them.  Matches the players/learners to their appropriate developmental level by providing adequate cognitive challenges.
<b>Embedding (3)</b>	<i>'assessing how closely the academic content is linked with the fantasy or story content – where fantasy refers to the narrative structure, story-lines, player experience, dramatic structure, fictive elements, etc.'</i> Ulicsak and Wright (2010:59).			
	<b>Level 0</b> The teachable'	<b>Level 1</b> Didactic elements	<b>Level 2</b> In addition to	<b>Level 3</b> In addition to

	<p>moments disrupt the players'/learners' gameplay that is the flow of the game has no interactive focus/hook either on the emotional, psychological, physical, or intellectual level.</p>	<p>are both present but are not cohesively integrated – one or the other is added as an afterthought to the first.</p> <p>Content to be learned is exogenous to the fantasy context of the game.</p>	<p>overcoming limitations and/or adding to Level 1 features, the following are also present:</p> <p>Allows for extended experiences with problems and contexts specific to the curriculum.</p> <p>Intellectual challenges are presented to players/learners of sufficient level to keep them interested in completing the game.</p>	<p>overcoming limitations and/or adding to Level 1 &amp; 2 features, the following are also present:</p> <p>Involves the players/learners both mentally and emotionally in such a way that they are conditioned to accept change and invest in the belief.</p> <p>Educational content is fully endogenous to the fantasy context.</p>
<b>Transfer (5)</b>	'how the player can use previous knowledge in other areas' (Ulicsak & Wright, 2010:59).			
	<p><b>Level 0</b> Offers no anchored or scaffolded levels of challenge, no evidence of using integrated content from previous levels, or little challenges at an increasing level of difficulty.</p> <p>Process knowledge is not mapped to targeted academic content.</p>	<p><b>Level 1</b> Offers levels of challenge that emphasize similar lines of thought and problem analysis to be applied to other implied contexts.</p> <p>Contains 3D cues and interactive animation that facilitate the transfer of knowledge during pedagogic events.</p>	<p><b>Level 2</b> In addition to overcoming limitations and/or adding to Level 1 features, the following are also present:</p> <p>Players/learners are able to progress through the levels easily. Active problem solving is required to move to the next level.</p> <p>Players/learners can progress through instructional elements that are introduced in a hierarchical manner so that knowledge gained during gameplay can be transferred to other situations.</p>	<p><b>Level 3</b> In addition to overcoming limitations and/or adding to Level 1 &amp; 2 features, the following are also present:</p> <p>Includes authentic real life experiences that reward meaningful "post-event" knowledge acquisition.</p> <p>Contains "after action reviews" that offers players/learners an opportunity to teach other (computation or actual) players/learners what they have learned.</p>
<b>Adaptation (4)</b>	'a change in behaviour as a consequence of transfer' (Ulicsak & Wright, 2010:59).			
	<b>Level 0</b> Fail to involve the	<b>Level 1</b> Builds upon the	<b>Level 2</b> In addition to	<b>Level 3</b> In addition to

	<p>players/learners in an interactive context.</p> <p>Information is not structured in a way that can be at least partially grasped by the learner.</p> <p>Does not sequence the material that is to be learned.</p>	<p>player's/learner's existing cognitive structures.</p> <p>New content is sequenced based on the principle of cognitive dissonance, as a result players'/learners' need to interpret events in order to determine what about the new content contradicts what they already know.</p>	<p>overcoming limitations and/or adding to Level 1 features, the following are also present:</p> <p>Instruction is designed to encourage the player– learners to go beyond the given information and discover new concepts for themselves.</p> <p>Content sequenced in such a way as to require players/ learners to identify old schema and transfer it to new ways of thinking.</p>	<p>overcoming limitations and/or adding to Level 1 &amp; 2 features, the following are also present:</p> <p>Makes learning an active, participatory process in which the players/learners construct new ideas based upon their prior knowledge.</p> <p>Presents information that focuses on external or internal characteristics that enable the learner to associate new information with previous learning.</p>
<b>Immersion (2)</b>	<i>'the player intellectually investing in the context of the game'</i> (Ulicsak & Wright, 2010:59).			
	<p><b>Level 0</b> Provides no progressive, formative feedback during each unit of gameplay.</p> <p>Presents little or no opportunity for reciprocal action and active participation for players/learners</p>	<p><b>Level 1</b> Elements of play are not directly involved with the didactic focus, but they do not impede or compete with pedagogic elements.</p> <p>Presents some opportunity for reciprocal action in a defined context, that is, a context that is meaningful, repeatable, and interactive, but players/learners do not feel fully interactive in the learning.</p>	<p><b>Level 2</b> In addition to overcoming limitations and/or adding to Level 1 features, the following are also present:</p> <p>Requires the player/learner to be involved cognitively, physically, psychologically, and emotionally in the game content.</p> <p>The use of mutual modelling creates a shared responsibility for learning among the participants.</p>	<p><b>Level 3</b> In addition to overcoming limitations and/or adding to Level 1 &amp; 2 features, the following are also present:</p> <p>Presents opportunity for reciprocal action and active participation for players/learners.</p> <p>Presents both the environment and the opportunity for belief creation.</p>
<b>Naturalisation (6)</b>	<i>"the development of habitual and spontaneous use of information derived within the game"</i> (Ulicsak & Wright, 2010:59).			
	<p><b>Level 0</b> Presents little opportunity for the mastery of facts or a particular skill.</p>	<p><b>Level 1</b> Replay is encouraged to assist in retention and to remediate</p>	<p><b>Level 2</b> In addition to overcoming limitations and/or adding to Level 1</p>	<p><b>Level 3</b> In addition to overcoming limitations and/or adding to Level 1 &amp;</p>

	<p>Target content/skills are rarely revisited.</p> <p>Little opportunity is given to build upon previous knowledge and/or skills in a logical and sequential manner.</p>	<p>shortcomings.</p> <p>Improves the speed of cognitive response, automaticity, and/or visual processing.</p>	<p>features, the following are also present:</p> <p>Encourages the synthesis of several elements and an understanding that once one skill is learned it leads to the easier acquisition of later elements.</p> <p>Requires the players/learners to make judgments about ideas and materials.</p>	<p>2 features, the following are also present:</p> <p>Causes players/learners to be aware of the content in such a way that they become efficient users of that knowledge.</p> <p>Causes the player/learners to spontaneously utilize knowledge habitually and consistently.</p>
--	--	---	--	--

As an example of the implementation of the RETAIN model, Table 11 shows the outcome of the evaluation of a serious game called Math Blaster by Gunter, Kenny and Vick (2008:532).

**Table 11:** Outcome of the evaluation of Math Blaster using the RETAIN framework  
(Gunter *et al.*, 2008:532).

<b>Element/Rating Level x Rank = Rating</b>	<b>Discussion</b>
Relevance (2) $2 \times 1 = 2$ total points	Overall the focus of learning various math principles are made apparent in the game, and is designed in such a way that it's enjoyable to much younger audiences. As a result, young children will have a desire to learn some principles because of the game's characters, and also because it is designed for that demographic.
Embedding (1) $1 \times 3 = 3$ total points	The game world is well designed and the learning is made apparent to the player from the start. The feel-good atmosphere of the game's world and characters are attractive to players. However, it also feels as if the game mechanics and pedagogy were developed independently of one another.
Transfer (1) $1 \times 5 = 5$ total points	Math is universal, and as a result, the principles learned from playing the game can be easily applied to other venues. The challenge of the game is very much like what would be observed in typical classroom instruction and creates the same sort of transfer. The animations add little to the learning of math during gameplay.
Adaptation (1.5)	The change in game mechanics for each play

1.5 x 4 = 6 total points	style presents a chance to test if the player really did learn the materials when doing it just a moment before in a different play style. In this manner, it builds on what has already been learned, and presents new principles that require the previous knowledge gained. Even though it is improving the player's way of thinking, it's not creating much in the way of discovery. The game does not facilitate the need to look at in what other instances math apply to the real world. A likely reason for this may be that the game world itself coincides so little with math that players may not see a reason why another world (real or not) should be mastered instead.
Immersion (1) 1 x 2 = 2 total points	There is some degree of immersion because the player is required to participate in some fashion in order to complete the game, but there is little beyond iteration in the immersion hierarchy. Outside of pedagogy-related mechanics, there are almost no other game elements. The game world does not fully create a compelling fantasy for players to stay active in— it becomes more about getting the math done and enjoying the reward of well-made artwork.
Naturalisation (0) 0 x 6 = 0 total points	Once the player has completed the game once, there is little else left to be accomplished. Certainly repeated play is encouraged but little variation is offered with regard to adding curiosity or novelty to the practice. Replaying the game does not add anything new for the player other than performing the same games over for the same knowledge— possibly acting as a refresher, but with little motivation to do so, once the novelty wears off.

#### 4.3.2.3. *Checklist for the Magic Bullet*

The Magic Bullet model classifies learning with games in four sets where learning belongs to at least one of the four sets (Becker, 2012:24). A different perspective is taken in the Magic Bullet model that cannot directly be compared with any of the other models or the framework in terms of the attributes evaluated. Table 12 depicts a checklist for the variables in the Magic Bullet model.

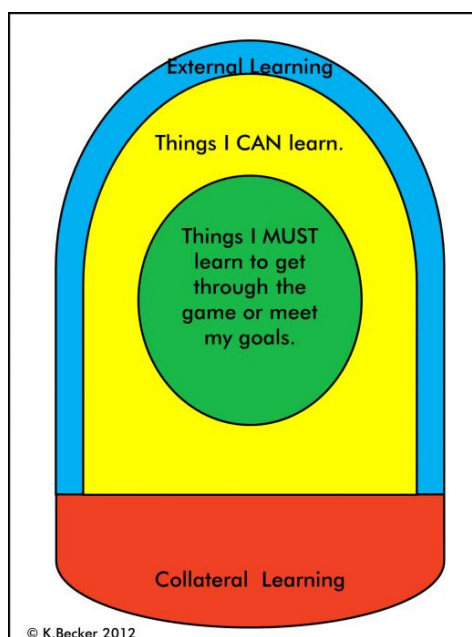
**Table 12:** Checklist for the Magic Bullet model

(Becker, 2012:24)

<b>Magic Bullet</b>	
<b>Checklist for evaluating the use of educational games and simulations</b>	
Things we CAN learn while playing a game.	When the game was designed specific learning elements were included as a deliberate goal by the creators of the game. These

	learning elements can include learning from all domains (cognitive, psychomotor and affective) and all categories (remembering, understanding, applying, analysing, evaluating and creating) (Anderson <i>et al.</i> , 2001). Learning is not essential to achieve the game's goal.
Things we <b>MUST</b> learn in order to complete the game.	This category consists of only those items that are crucial for winning or to complete the game. Sometimes it may be necessary to qualify these items with an if-then statement as many games allow for more than one way to win or to get to the end of the game.
Things we learn as a result of playing the game but are not part of the game (collateral learning).	This category includes other things that can be learned or an emergent behaviour that are not part of the game and do not impact on the player's success in the game.
Things we learn outside the game that are helpful when the game is played again (external learning).	External learning takes place outside the game for instance in fan sites or social events or where game guides are provided.

Figure 4 refer back to section 2.6.4 and summarize what Becker (2013:5) calls a good-balanced game. The ideal situation is where what I **MUST** learn is completely inside what I **CAN** learn and it is possible that external and collateral learning can also take place. This encourages both collateral and external learning and provides students the opportunity to learn more than that expected to complete the game.



**Figure 12: A well-balanced Magic Bullet**  
(Becker, 2013:5)

### **4.3.3. Action taking: first cycle**

During the action planning phase certain actions were identified and were implemented during the action taking phase. Susman and Evered (1978) suggest that a directive approach in which the research 'directs' the change, or non-directive, in which the change is applied indirectly, can be followed. In this study it was decided to let the research direct the change. Participants used the checklists and examples provided to them to evaluate each of the models and the framework using any serious games of their choice applied on any module that he/she was lecturing. After evaluating the models participants were asked to complete a questionnaire consisting of Likert-scale and open-ended questions. This action taking process was executed individually.

### **4.3.4. Evaluating: first cycle**

According to Goede *et al.* (2013:254) the analysis of the success of the intervention is the most important in any critical research project. The actions taken during the action phase are evaluated in the evaluation phase of the action research cycle. This includes determining whether the theoretical implementation of the action were realised and whether the problems were solved by these effects (Susman & Evered, 1978). During the action phase, participants evaluated the different models and the framework and completed a questionnaire to indicate their views on the different models and framework. Data from the questionnaires were captured and analysed using frequency analysis. The results are described next.

#### **4.3.4.1. *Analysis of the data***

- *It was easy for me to understand the model.* Participants were presented with a brief description of each model that included the main philosophy of the model, the aims of the model, and the 'layout' of the model. The participants indicated that all the models and the framework were fairly good understood,

with a score of 83 percent for the Magic Bullet model, 83 percent for the RETAIN model and 100 percent for the four-dimensional framework.

- *The model is clear and easy to use.* Participants found the RETAIN and the four-dimensional framework easier to use than the Magic Bullet model with overall scores of 83 percent for the RETAIN model and 100 percent for the four-dimensional framework. The Magic Bullet model scored only 50 percent.
- *I found the model to be useful.* This study aim to identify a model that can be used to select a suitable serious game (or games) to enhance the learning experience in the Computer Science class. To select the serious game (or games) the selection tool (framework or model) must be helpful in assisting the educator in the selection process. The participants scored the helpfulness of the Magic Bullet model lower (17%) than the helpfulness of the RETAIN model (83%) and the four-dimensional framework (83%).
- *I would use this model again if I need to evaluate a game for class use.* One way to determine user satisfaction in terms of appropriateness and usefulness of the specific model is to determine whether the user will use the model again in future to evaluate serious games for use in class. In response to this question participants voted in favour of the RETAIN Model (67%) and the four-dimensional framework (67%). The Magic Bullet Model was rated lower with a score of 17 percent.
- *I will suggest the use of this model to colleagues when they need to evaluate games for class use.* This question relates to the previous question in the sense that it also evaluates the usefulness of the specific model with the added expectation that the model will be recommended to colleagues when they wanted to select serious games to enhance the learning experience of learners. In this case the four-dimensional framework was rated the highest score of 83 percent while the RETAIN model scored 67 percent and the Magic Bullet 17 percent.
- *This model does not address the needs when it comes to evaluating games for class use.* The main purpose of any model used to select a serious game for use in class is to address the objectives of the learning module in consideration. The majority of participants agreed that the Magic Bullet model

(with a score of 83 percent) did not address the requirements to evaluate games for the Computer Science class. The RETAIN model rated at 33 percent was a more preferred choice but the four-dimensional framework with a score of 17 percent was voted the best model to address the evaluation criteria for selecting a serious game for the Computer Science class.

- *I found the use of this model to be a waste of time.* This question is closely linked to the previous question and addressed the usefulness of the models and the framework. If a model seems to be useless it will be evaluated as a waste of time to use the model for selecting serious games. The majority of participants indicated that the use of the Magic Bullet model was a waste of time with a score of 67 percent. The RETAIN model (17%) and the four-dimensional framework (17%) were not perceived as a waste of time in evaluating a serious game for the Computer Science class.
- *This model adds any value when evaluating a game.* The main purpose of any model used in selecting serious games to assist learners and to enhance the learning environment is to add value to the selection and evaluation process of the serious game. When asked whether the model does add value to the selection process participants agreed that the four-dimensional framework (83%) is far better than the RETAIN model (67%) and the Magic Bullet model (50%).

If the desired changes were unsuccessful the next iteration of the action research cycle should establish a framework for correcting the situation (Susman & Evered, 1978). The open-ended questions revealed a major problem (see section 4.4.1) and during discussions between the researcher and participants it was decided to repeat the action research cycle and a second cycle was initiated.

#### **4.4. Action research: second cycle**

##### **4.4.1. Diagnosing: second cycle**

A major problem was identified during the first cycle of the action research cycle. The open-ended questions revealed that participants spend on average four working days ( $4 \times 8 = 32$  hours) to understand the models and the framework, work through the examples provided to them and to evaluate the serious games according to the models and the framework. Participants were at first overwhelmed by the checklists provided to them. This necessitates an intervention in the selection of a serious game process and the action planning phase was initiated.

##### **4.4.2. Action planning: second cycle**

In consultation with the participants it was decided to repeat the action research for a second time. It was mutually decided that this time the games to be evaluated were provided to them and they jointly applied the models and the framework to a specific module in Computer Science in a workshop setup. Two games, ColoBot and Light-Bot 2.0, were provided to participants. This strategy was decided upon to try to overcome the problem described in the diagnosing phase of the second cycle of the action research. The selected two games and the collaborative application of the models and the framework are described next.

###### **4.4.2.1. *ColoBot***

ColoBot is a game that can assist learners in learning programming. The game has a third person view, meaning the control of an avatar while viewing it as it moves across the 3D environment. The game includes missions on different planets, many useful machines, helpful robots and angry aliens. The mission of the game is to use robots to successfully complete expeditions on other planets. You have to search for the raw materials and energy needed in order to survive. New robots and machines can be built from raw materials. Robots can be controlled directly, but the idea is to

program their movements. In a simple programming language similar to Java, you can write a program for the robot so that it will automatically carry out activities, allowing you to sit back and watch as it collects materials and fights enemies.

Figure 13 depicts a screenshot of the game showing the typical play environment.



**Figure 13:** Screenshot of ColoBot

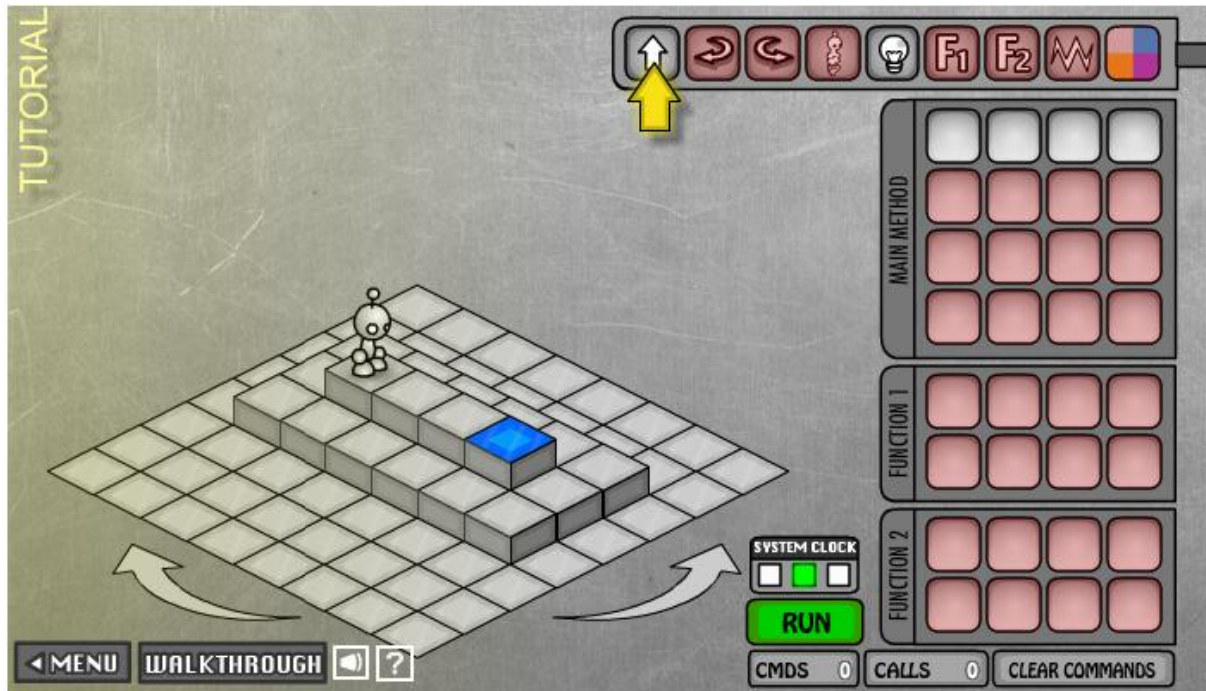
(<http://www.ceebot.com/>)

#### 4.4.2.2. *Light-Bot 2*

The second game provided to the participants was Light-Bot 2.0. Light-Bot 2.0 is also a game that can assist students in learning programming concepts. The goal of the game is to move a bot across the environment to switch on a light. This task is accomplished by using icons on the screen and placing them in an instruction list.

This game seems very simple but can test logical thinking in various forms. The user can create custom levels adding to the usefulness of the game.

Figure 14 depicts a screenshot of Light-Bot 2.0. In the upper-right corner the available commands for the current level is shown.



**Figure 14:** Screenshot of Light-Bot 2

(<http://armorgames.com/play/6061/light-bot-20>)

#### 4.4.3. Action taking: second cycle

Participants gained some experience of the models and framework during the first cycle of the action research. During the workshop the models and the framework were again briefly described so that all participants understood the models and the framework and the philosophy behind each model and framework. ColoBot was introduced and demonstrated and participants had the opportunity to play the game to gain some experience. When all participants were confident with the models and the framework and the game they jointly completed the models and the framework in turn and rated the games according to the models and the framework. Table 13

depicts the completed RETAIN framework for ColoBot while the score calculated for this game is shown in Table 14 (see section 2.6.1).

**Table 13: Completed RETAIN framework for ColoBot**

<b>CATEGORY 1: Relevance</b>		
Level 0	Little stimulus for learning	
Level 1	Limited educational focus, some irrelevant content	X
Level 2	Learning objectives are defined, interest is created	
Level 3	Game is relevant to learners, and challenges or adequate for learning	
<b>CATEGORY 2: Embedding</b>		
Level 0	Learning content disrupts play	
Level 1	Learning is exogenous to fantasy context (learning is 'outside' the fantasy context)	
Level 2	Includes intellectual challenges and problems	
Level 3	Content is endogenous to fantasy and fully involves learner	X
<b>CATEGORY 3: Transfer</b>		
Level 0	No levels of challenge mapped to objectives	
Level 1	Levels of challenge are too similar, some useful content	
Level 2	Easy progress through levels through active problem-solving. Higher level knowledge should be transferable	X
Level 3	Authentic real life situations and after action reviews	
<b>CATEGORY 4: Adaption</b>		
Level 0	Fails to engage in interactive, unstructured information	
Level 1	Builds upon existing cognitive structures, engages in cognitive conflict	
Level 2	Learners are encouraged to go beyond given information. Old schemas are identified and adapted to new situations	X
Level 3	Learning becomes an active process that integrates prior knowledge	
<b>CATEGORY 5: Immersion</b>		
Level 0	No formative feedback, little active participation	
Level 1	Elements of play are not in sync with learning objectives, players do not feel fully interactive	
Level 2	Learners are involved cognitively, physically and emotionally	X
Level 3	Favours belief creation and includes opportunities for reciprocal action	
<b>CATEGORY 6: Naturalisation</b>		
Level 0	Little opportunity for mastery of facts and skills	
Level 1	Replay is encouraged to improve speed of processing	
Level 2	Encourages synthesis of elements and judgments	
Level 3	Learners become efficient content users and spontaneously use acquired knowledge	X

**Table 14: Scoring table for ColoBot**

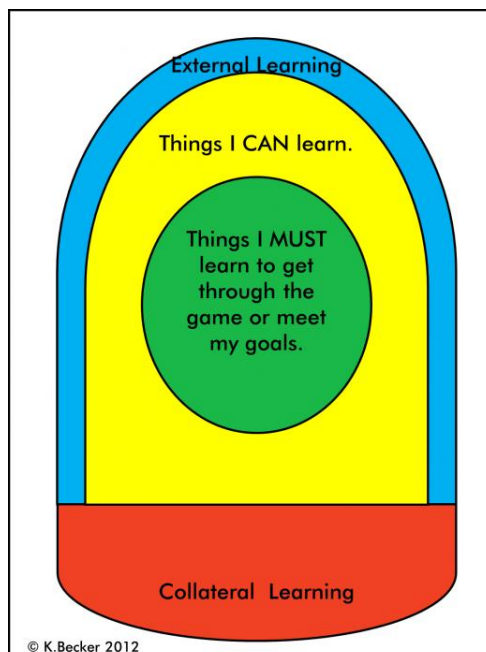
	<b>Order of importance</b>	<b>Level 0</b>	<b>Level 1</b>	<b>Level 2</b>	<b>Level 3</b>	<b>Score</b>
Relevance	1	0	1	2	3	1
Embedding	3	0	3	6	9	9
Transfer	5	0	5	10	15	10
Adaptation	4	0	4	8	12	8
Immersion	2	0	2	4	6	4
Naturalisation	6	0	6	12	18	18
					<b>Total</b>	<b>50</b>

Table 15 indicates the outcomes for the four-dimensional framework for Colobot as decided by the participants.

**Table 15:** Completed four-dimensional framework for Colobot

<b>Content</b>	<b>Learner specification</b>	<b>Pedagogic consideration</b>	<b>Mode of representation</b>
<p>University-based learning.</p> <p>The game is only a demo and the use of the real game would require the buying of licenses.</p>	<p>First year programming student</p> <p>The students do not have any prior experience with programming but are familiar with the basic components of a computer.</p> <p>The game will support a range of different learning styles.</p> <p>The game can be used by groups trying to solve various programming problems.</p>	<p>The game mostly involves activity-based theory as the aim is to solve problems but an experiential learning cycle could also be used as the game allows the player to run it and see what happens.</p> <p>The game does support the curriculum objectives as it covers all important outcomes like decision structures, repeating structures and the use of methods.</p> <p>The learning outcomes of the game are closely related to that of ITSP 114.</p> <p>Learning activities in this game focuses on problem-solving. The game challenges the student with problems that must be solved by using programming instructions.</p> <p>The game can be used closely with traditional learning as the game can be used after each new concept learned to solve a problem in the game using the new concepts.</p>	<p>The game creates an immersive environment and learners can quickly be drawn into gameplay trying to enhance their skill by completing missions.</p> <p>The level of fidelity (immersion) created by the game is adequate for the purpose of the game.</p> <p>The level of realism in the game is adequate, although the machines commanded in the game are in an outer space world it is easy to see how machines can be programmed in real world scenarios.</p> <p>There is a direct link between the work done in class and the instructions needed to complete a mission. If the educator plans it well, the outcomes can be aligned.</p>

Colobot has a large 3D environment and the learners can navigate an avatar through the environment learning things not necessarily part of the missions. External learning is supported as the learner can consult player forums on the Internet and other sources for help when they encounter problems in solving game problems. Collateral learning is also encouraged to a certain extent as the 3D environment provided a multitude of possibilities where the learner may want to try new ideas. The learner may want to read more about certain concepts and then try them in the game. Participants jointly selected the Magic Bullet presentation as shown in Figure 15 from this discussion.



**Figure 15:** Magic Bullet representing Colobot

The second serious game, Light-Bot 2, was introduced and demonstrated and as in the case of the first serious game, participants had the opportunity to play the game to gain some experience. When all participants were confident with the game they again jointly completed the models and the framework in turn and rate the game according to the models and the framework.

Using the RETAIN framework, Table 16 depicts the results for Light-Bot 2 while the score calculated for this game is shown in Table 17.

**Table 16: Completed RETAIN framework for Light-Bot 2**

<b>CATEGORY 1: Relevance</b>		
Level 0	Little stimulus for learning	
Level 1	Limited educational focus, some irrelevant content	
Level 2	Learning objectives are defined, interest is created	
Level 3	Game is relevant to learners, and challenges or adequate for learning	X
<b>CATEGORY 2: Embedding</b>		
Level 0	Learning content disrupts play	
Level 1	Learning is exogenous to fantasy context (learning is 'outside' the fantasy context)	
Level 2	Includes intellectual challenge and problems	
Level 3	Content is endogenous to fantasy and fully involves learner	X
<b>CATEGORY 3: Transfer</b>		
Level 0	No levels of challenge mapped to objectives	
Level 1	Levels of challenge are too similar, some useful content	
Level 2	Easy progress through levels through active problem-solving. Higher level knowledge should be transferable	X
Level 3	Authentic real life situations and after action reviews	
<b>CATEGORY 4: Adaption</b>		
Level 0	Fails to engage in interactive, unstructured information	
Level 1	Builds upon existing cognitive structures, engages in cognitive conflict	
Level 2	Learners are encouraged to go beyond given information. Old schemas are identified and adapted to new situations	X
Level 3	Learning becomes an active process that integrates prior knowledge	
<b>CATEGORY 5: Immersion</b>		
Level 0	No formative feedback, little active participation	
Level 1	Elements of play are not in sync with learning objectives, players do not feel fully interactive	
Level 2	Learners are involved cognitively, physically and emotionally	X
Level 3	Favours belief creation and includes opportunities for reciprocal action	
<b>CATEGORY 6: Naturalisation</b>		
Level 0	Little opportunity for mastery of facts and skills	
Level 1	Replay is encouraged to improve speed of processing	
Level 2	Encourages synthesis of elements and judgments	
Level 3	Learners become efficient content users and spontaneously use acquired knowledge	X

**Table 17: RETAIN scores for ColoBot**

	<b>Order of importance</b>	<b>Level 0</b>	<b>Level 1</b>	<b>Level 2</b>	<b>Level 3</b>	<b>Score</b>
Relevance	1	0	1	2	<b>3</b>	3
Embedding	3	0	3	6	<b>9</b>	9
Transfer	5	0	5	<b>10</b>	15	10
Adaptation	4	0	4	<b>8</b>	12	8
Immersion	2	0	2	<b>4</b>	6	4
Naturalisation	6	0	6	12	<b>18</b>	18
					<b>Total</b>	<b>52</b>

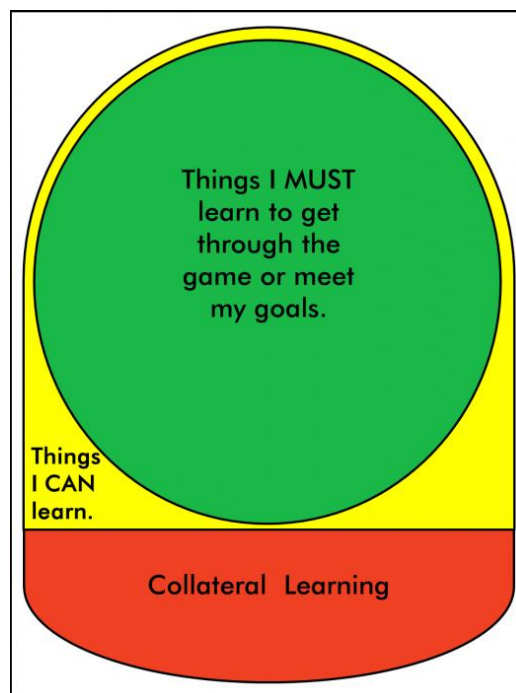
Table 18 indicates the outcomes for the four-dimensional framework for Light-Bot 2 as decided on by the participants.

**Table 18:** Completed four-dimensional framework for Light-Bot 2

<b>Content</b>	<b>Learner specification</b>	<b>Pedagogic consideration</b>	<b>Mode of representation</b>
<p>University-based learning.</p> <p>The game is web-based this make it easy to use in class as there is no pre-installation required.</p> <p>The game is free and can be used by anyone with internet access.</p>	<p>First year programming student</p> <p>The students do not have any prior experience with programming but are familiar with the basic components of a computer.</p> <p>The game will support a range of different learning styles.</p> <p>The game can be used by groups trying to solve various programming problems.</p>	<p>The game mostly involves activity based theory as the aim is to solve problems but an experiential learning cycle could also be used as the game allows the player to run it and see what happens.</p> <p>The game does support the curriculum objectives as it covers all important outcomes like decision structures, repeating structures and the use of methods.</p> <p>The learning outcomes of the game is closely related to that of ITSP 114</p> <p>Learning activities in this game focuses on problem-solving. The game challenges the student with problems that must be solved by using instruction icons.</p> <p>The game can be used closely with traditional learning as the game can be used after each new concept learned to solve a problem in the game using the new concepts.</p>	<p>The game creates an immersive environment and learners can quickly be drawn into gameplay trying to enhance their skill by solving problems.</p> <p>The level of fidelity (immersion) created by the game is adequate for the purpose of the game.</p> <p>The level of realism in the game is adequate, although the bot commanded in the game perform simple instructions. It is easy to see how machines can be programmed in real world scenarios to do simple tasks.</p> <p>There is a direct link between the work done in class and the instructions needed to complete a mission. If the lecturer plan it well the outcomes can be aligned.</p>

LightBot 2.0 does not offer a ‘fast’ environment that the learner can explore. The environment is limited with respect to problem-solving and instructions available to solve the problem. This may be frustrating to some learners, but it can be argued

that learners who are struggling with programming concepts will be tempted to explore the environment rather than to focus on solving the problem. Learners can also read more about a particular concept when they struggle to solve a problem or to expand their knowledge. Participants jointly selected the Magic Bullet presentation as shown in Figure 16.



**Figure 16:** Magic Bullet representing Light Bot 2

#### **4.4.4. Evaluating: second cycle**

'Critical social research projects are only completed and successful if the oppressed party is emancipated' (Goede *et al.*, 2013:254). In this case the educator who wants to select a serious game for the Computer Science class is the oppressed party and the project will only be successful if the educator can successfully identify (or reject) a serious game in an acceptable (for the educator) time frame using an appropriate selection model. The problem identified during the initial diagnosis phase of the second cycle of the action research was addressed in the planning phase of the second cycle. The time spend by participants to understand the models and the framework, work through the examples provided to them and to evaluate the serious

games according to the models and the framework were reduced from four working days to one working day in the action phase of the second cycle.

During a feedback session at the end of the workshop participants were asked to express their thoughts about the models and the framework. The outcomes of this discussion are in line with the results from the profile of the participants. The results are discussed next.

- *It was easy for me to understand the model.* Participants again indicated that it was not difficult to understand the models and the framework and again rated the four-dimensional framework as the most preferred model above the RETAIN and Magic Bullet models.
- *The model is clear and easy to use.* Both the RETAIN and the four-dimensional framework were easier to use than the Magic Bullet but the four-dimensional framework was easier to use than the RETAIN model.
- *I found the model to be useful.* Participants scored the helpfulness of the Magic Bullet model much lower than the other two frameworks. The RETAIN model and four-dimensional framework were on the same scale.
- *I would use this model again if I need to evaluate a game for class use.* Participants were unanimous that they will definitely use the four-dimensional framework if they need to evaluate serious games for the Computer Science class.
- *I will suggest the use of this model to colleagues when they need to evaluate games for class use.* In response to this question participants ranked the models and the framework in the order they will recommend them to colleagues as follows: First the four-dimensional framework, second the RETAIN model and lastly the Magic Bullet model.
- *This model does not address the needs when it comes to evaluating games for class use.* As suspected from the reaction on the previous question the order in which participants ranked the models and the framework in terms of not addressing the needs to evaluate serious games as exactly the opposite: First the Magic Bullet, then the RETAIN and lastly the four-dimensional model.

- *I found the use of this model to be a waste of time.* Participants agreed that all the models and the framework are useful and not a waste of time because educators can use them to select a serious game.
- *This model adds any value when evaluating a game.* The main purpose of any model used in selecting serious games is to add value to the selection and evaluation process of the serious game. Participants agreed that the four-dimensional framework is more valued than the RETAIN and Magic Bullet models.

#### **4.5. Specifying learning**

The specifying learning phase is an ongoing process and formally undertaken lastly (Susman & Evered, 1978). The knowledge gained by using action research may be used in different ways (see section 3.4.1.3).

- New knowledge may lead to the restructuring of organisational norms to reflect the new knowledge gained during the study. It was not the aim of this study to restructure any organisational norms. The knowledge gained in this research may be used to restructure educational content or presentation methods.
- The purpose of action research is to navigate change in a problem situation. If the change was unsuccessful the knowledge gained may provide foundations for analyses in planning for further action research interventions. In this research the knowledge gained during the first cycle of the action research was used to initiate the second cycle of action research.
- The success or failure of the theoretical framework used during the different cycles of action research provides valuable knowledge to researchers. This information can be used in future research settings. The knowledge gained in this study will be applied when serious games have to be selected for the Computer Science class.

#### **4.6. Conclusion**

This chapter described the research process that was followed in this study. The research strategy was outlined and the research environment described. The application of action research cycles as applied to the research problem was outlined. During the first cycle of the action research process participants were expected to evaluate the models and the framework designed to aid in the selection of serious games for use in class. This process was done individually and a questionnaire was used to gather data about the participants' experiences with the models and the framework. The knowledge gained during the first cycle of the action research process was used to initiate the second cycle of action research. This time participants worked as a group and two serious games were provided to them. This second cycle resolved the problem identified during the first cycle and the time taken to evaluate the models and the framework was reduced from four working days to one working day.

## **CHAPTER FIVE: CONCLUSIONS, RECOMMENDATIONS AND FUTURE RESEARCH**

### **5.1. Introduction**

The objective of this study was to identify and recommend a model that can be used to select serious games for the Computer Science class. The previous chapters set the scene to realise this objective by first conducting a literature study on serious games as well as on selected models and a framework used in the research to select and evaluate serious games for teaching and learning. A discussion of research paradigms, research methods and data collection techniques followed. An empirical study commenced using Critical Social Theory and action research to evaluate the models and the framework with the aim to identify an appropriate model or framework for selection of serious games for the Computer Science class. The action research cycle was repeated twice using mixed methods to collect data used to evaluate participant's experiences with the different models and framework.

This chapter concludes the research by reflecting on the research process and the results obtained.

### **5.2. Research conclusions**

This section concludes the study with reflection on the research objective and research questions and aligns it with the execution of the research and the findings.

Research questions were formulated to realise the objective to identify and recommend a model that can be used to select serious games for the Computer Science class.

### **5.2.1. First research question**

The first research question asked, 'What models or frameworks are available for selecting serious games for educational use?' A literature survey revealed the existence of a number of frameworks or models that were developed to assist in the evaluation of games. Examples are the TILT framework, the Flashlight framework and the CIAO! Framework. Two models, a framework and a project namely the RETAIN model, the four-dimensional framework, the Levee Patroller project and the Magic Bullet model were found to be more popular as they were often cited and discussed in scientific journals. These two models, a framework and a project were discussed in Chapter 2. The identification of these two models, a framework and a project answers the first research question.

### **5.2.2. Second research question**

The second research question was 'What similarities and differences are there between existing models used for selecting serious games for use in class?' This question was addressed in Chapter 2 (section 2.7).

### **5.2.3. Third research question**

The third and final research question asked, 'Which model will be the most appropriate for selecting serious games for the Computer Science class?' Reflection on the action research conducted in Chapter 4 answered this research question.

#### **5.2.3.1. *Action research: first cycle***

The literature survey presented the problem that initiated this research. During the first cycle of the action research the problem was confirmed by the participants when they completed a questionnaire and 57,9 percent indicated that it will be very difficult

to find a serious game for the specific subject that they present. During the action planning phase it was decided that participants will be given the opportunity to evaluate a serious game using each of the following models and the framework: the RETAIN model, the four-dimensional framework and the Magic Bullet model. Checklists and examples were made available to the participants. The evaluation of the models and the framework was done during the action taking phase. Following the action taking phase participants evaluated the models and the framework during the evaluation phase of the action research process. A questionnaire consisting of Likert-type questions and open-ended questions was used to collect data. Frequency analysis (n = 18) on the Likert-type questions revealed the results as presented in summarised format in Table 19.

**Table 19:** Summary of evaluation of the models and framework – first cycle

	<b>four-dimensional framework</b>	<b>RETAIN model</b>	<b>Magic Bullet model</b>
Easy to understand	100%	83%	83%
Easy to use	100%	83%	50%
Usefulness	83%	83%	17%
Will use model again	67%	67%	17%
Recommend model to colleagues	83%	67%	17%
Address needs	83%	66%	17%
Not a waste of time	83%	83%	33%
Adds value	83%	67%	50%
	<b>85.25%</b>	<b>74.88%</b>	<b>35.50%</b>

It is clear from the results obtained at the end of the first cycle of the action research that participants valued the four-dimensional framework more than the RETAIN and the Magic Bullet models.

### 5.2.3.2. *Action research: second cycle*

Another problem identified from the open-ended questions, instigated the second cycle of action research. When the models and the framework were evaluated during the first cycle of the action research, participants indicated that it took on average

four working days to complete the process. This was considered to be too long and the planning phase of the second cycle was initiated. During the planning phase of the second cycle it was decided that a serious game would be provided to the participants and that all participants would work together as opposed to working as individuals to evaluate the models and the framework. In the action phase participants worked as a group to evaluate the models and the framework. During the evaluation phase a feedback session was held and participants were given the opportunity to express their thoughts on the models and framework. The outcome of the brainstorming session is summarised in Table 22.

**Table 20:** Summary of evaluation of the models and framework – second cycle

<b>Questions</b>	<b>Participants' responses</b>
Easy to understand	It was not difficult to understand the models and the framework and the four-dimensional framework was preferred above the RETAIN and Magic Bullet models.
Easy to use	Participants indicated that the RETAIN model and the four-dimensional framework were easier to use than the Magic Bullet but the four-dimensional framework was the easiest to use.
Usefulness	The Magic Bullet model was scored much lower than the other two frameworks with the RETAIN and four-dimensional framework on the same scale.
Will use model again	Participants were unanimous that they will definitely use the four-dimensional framework if they need to evaluate serious games for the Computer Science class.
Recommend model to colleagues	Participants ranked the models and the framework in the order they will recommend them to colleagues as follows. The four-dimensional framework, then the RETAIN model and lastly the Magic Bullet model.
Address needs	The order in which participants ranked the models and the framework in terms of addressing the needs to evaluate serious games is firstly the four-dimensional framework, secondly the RETAIN model and lastly the Magic Bullet model.
Waste of time	It was agreed that all the models and the framework are useful and not a waste of time and can be used to select serious games.
Adds value	Participants agreed that the four-dimensional framework adds more value than the RETAIN and Magic Bullet models.

#### 5.2.3.3. *Specifying learning*

According to Susman and Evered (1978) the specifying learning phase is formally undertaken lastly and Baskerville (1999:16) indicated different ways in which the knowledge gained by using action research may be used. Firstly the new knowledge may lead to the restructuring of organisational norms to reflect the new knowledge gained during the research. This study did not aim to restructure any organisational norms but restructuring of lecture content or the presentation methods may be possible from the knowledge gained by this research. Secondly, the purpose of action research is to navigate change in a problem situation. This study suggests that if serious games have to be part of lectures in Computer Science, models can be used to select suitable games for the class. Lastly, the success or failure of the theoretical framework used during the different cycles of action research provides valuable knowledge to researchers. This information can be used in future research settings. The knowledge gained in this study can be applied to do further research on selection models and frameworks for example to refine the four-dimensional framework or to write guidelines on how to use the selection models and framework.

This concludes the summary of the two cycles and the five phases of action research executed as described in Chapter 4. The next section addresses the last research question, namely 'Which model will be the most appropriate for selecting serious games for the Computer Science class?'

### **5.3. Research findings**

The aim of this research was to identify or recommend a suitable model for selecting serious games for the Computer Science class.

### **5.3.1. First finding**

It is clear from the results presented in Chapter 4 and summarised in Table 19 and Table 20 that the four-dimensional framework was rated above the RETAIN model and the Magic Bullet model.

### **5.3.2. Second finding**

This study found that the selection of serious games for use in Computer Science classes may take a long time to execute if it is performed individually by educators. If the selection process is performed in a group setting the duration of the selection process is reduced by about 75 percent.

## **5.4. Recommendations**

The results documented and discussed in Chapter 4 and summarised in this chapter indicates that this study recommends the four-dimensional framework as an appropriate model for selecting serious games for the Computer Science class.

## **5.5. Research limitations**

The limitations of this study are explained from a research execution and a research results perspective. The research execution refers to the challenges faced throughout the execution of the research and the research approach. The research results refer to the limitations of the derived results.

The most significant limitation of this study is the number of universities as well as the number of participants who were involved in this study. This study involved only two universities in the Gauteng province of South Africa (there are twenty-five universities in South Africa). The geographical location of the different universities makes it very difficult to involve more universities when action research is used as a

research method as action research is a 'process of participatory observation' (Baskerville, 1999:6). This implies that the researcher is part of each the five phases and of the different cycles of action research.

The research results and specifically the recommendation that the four-dimensional framework should be used to select serious games for the Computer Science class have their limitations. Firstly the limited number of Computer Science educators who participated in this research may have a huge influence on the results of a study of this nature. Secondly, the results described in Chapter 4 and summarised in Table 19 could be different if only a few more educators were involved in this research. There is a possibility that data saturation was not reach with the few participants involved in the study. Therefore involving more participants could lead to a different outcome to this study.

## **5.6. Future research opportunities**

An opportunity for future research would be to expand this research to include more universities and to involve more Computer Science educators. Another opportunity is to determine if there is a need to develop either more simplified models and/or guidelines on how to use these serious game selection models and frameworks.

## **5.7. Contributions to the body of information**

As mentioned in Chapter 1 the literature survey did not reveal any research where the identified models or the framework were used to select serious games for the Computer Science class. This research fills that gap.

## **5.8. Conclusion**

Chapter 5 concluded this research with a presentation of a summary of the derived conclusions, the limitations of the study, future research and the contribution to the Computer Science body of knowledge.

## Bibliography

- Adebesin, F., Kotzé, P. & Gelderblom, H. 2011. Design research as a framework to evaluate the usability and accessibility of the digital doorway. (*In Appiah, E., Mlitwa N. & Anyomi D., eds. Proceedings of the 2011 Design, Development and Research Conference organised by Cape Peninsula University of Technology. p. 310-327).*
- Anderson, L.W., Krathwohl, D.R., & Bloom, B.S. 2001. A taxonomy for learning, teaching, and assessing: a revision of Bloom's taxonomy of educational objectives (Complete ed.). New York: Longman.
- Bacon, C.J. & Fitzgerald, B. 2001. A systemic framework for the field of information systems. *The data base for advances in information systems*, 32(2):46-67.
- Baskerville, R. & Wood-harper, A.T. 1998. Diversity in information systems action research methods. *European Journal of Information Systems*, 7:90-107.
- Baskerville, R.L. 1999. Investigating information systems with action research. *Communication of the association for information systems*, 2(19):2-31.
- Becker, K. 2007. Battle of the titans: Mario vs. MathBlaster. *World conference on educational multimedia, hypermedia and telecommunications*. p. 2707-2716.
- Becker, K. 2012. A Magic Bullet for Assessing Games for Learning. *Society for Information Technology & Teacher Education International Conference*. p. 2474-2479.
- Becker, K. 2013. Magic bullet game analysis. <http://www.minkhollow.ca/becker/doku.php?id=pf:game-reviews:magic-bullet>. Date of access: 21 August 2014.
- Blum, F.H. 1995. Action research: A scientific approach? *Philosophy of science*, 22(1):1-7.
- Bogost, I. 2010. Playing Political Games On the white House and video games. [http://www.bogost.com/blog/playing\\_political\\_games.shtml](http://www.bogost.com/blog/playing_political_games.shtml). Date of access: 30 January 2014.
- Bryant, A. 2002 Grounding systems research: Re-establishing grounded theory. System Sciences. *HICSS. Proceedings of the 35th Annual Hawaii International Conference. IEEE*, 3446-3455.
- Bryman, A. 2006. Mixed methods: A four volume set. London: Sage.
- Bryman, A., Becker, S. & Sempik, J. 2008. Quality criteria for quantitative, qualitative and mixed methods research: A view from social policy. *International Journal of Social Research Methodology*, 11(4):261-276.
- Burrell, G. & Morgan, G. 1979. Sociological paradigms & organisational analysis: elements of sociology of corporate life. London: Heineman Educational Books.

- Collins, H. 2010. *Creative research: the theory and practice of research for the creative industries*, Ava Publishing.
- Crawford, C. 1984. *The Art of Computer Game Design*.  
[http://www.vic20.vaxxine.com/wiki/images/9/96/Art\\_of\\_Game\\_Design.pdf](http://www.vic20.vaxxine.com/wiki/images/9/96/Art_of_Game_Design.pdf). Date of access: 27 November 2014.
- Creswell, J.W., & Plano Clark, V.L. 2011. *Designing and conducting mixed methods research*. Los Angeles: SAGE Publications.
- De Villiers, M. 2005. Three approaches as pillars for interpretive information systems research: development research, action research and grounded theory. (Proceedings of the 2005 annual research conference of the South African institute of computer scientists and information technologists on IT research in developing countries organised by South African Institute for Computer Scientists and Information Technologists, p. 142-151).
- De Freitas, S. & Jarvis, S. 2008. Towards a development approach for serious games. *Games-based learning advancements for multi-sensory humancomputer interfaces: Techniques and effective practices*. IGI Global. Hershey, PA.
- De Freitas, S. & Oliver, M. 2006. How can exploratory learning with games and simulations within the curriculum be most effectively evaluated? *Computers & Education*, 46(3):249-264.
- De Freitas, S. 2006. Learning in immersive worlds: a review of game based learning, JiSC. <http://www.jisc.ac.uk/whatwedo/programmes/elearninginnovation/outcomes.aspx>. Date of access: 12 May 2013.
- Denner, J., Werner, L. & Ortiz, E. 2012. Computer games created by middle school girls: Can they be used to measure understanding of computer science concepts? *Computers & Education*, 58:240-249.
- Denzin, N.K., & Lincoln, Y.S. 2003. Introduction: The discipline and practice of qualitative research. (In Denzin, N.K., & Lincoln, Y.S., eds. *The Landscape of Qualitative Research*. New Delhi, India: SAGA Publications. p. 1-45).
- Dickey, M. 2007. Game Design and Learning: A conjectural analysis of how Massively Multiple Online Role-Playing Games (MMORPGs) foster intrinsic motivation. *Educational Technology Research & Development*, 55(3):253-273.
- Egenfeldt-Nielsen, S. 2005. *Beyond Edutainment: Exploring the Educational Potential of Computer Games*. Copenhagen: IT-University of Copenhagen (Dissertation: PhD).
- Ehrmann, S.C. 1998. Studying teaching, learning and technology: A tool kit from the flashlight program. *Active Learning*, 36-39.
- Egenfeldt-Nielsen, S. 2011. *Digital solutions for education, "entertain, engage & educate"*, Copenhagen, Denmark: Serious Games Interactive.
- Feilzer, M.Y. 2010. *Doing mixed methods research pragmatically: Implications for*

the rediscovery of pragmatism as a research paradigm. *Journal of Mixed Methods Research*, 4:6-16.

Fitzgerald, B. & Howcroft, D. 1998. Competing Dichotomies in IS Research and Possible Strategies for Resolution (*In Proceedings of the 19th International Conference on Information Systems organised by ICIS, Helsinki, Finland, p. 155-164*).

Fowler, F.J.J. 2009. *Survey research methods*, United States of America: Sage Publications, Inc.

Garris, R., Ahlers, R., & Driskell, J.E. 2002. Games, motivation, and learning: A research and practice model. *Simulation & Gaming*, 33:441-467.

Gee, J. & Shaffer, D. 2010. *Looking where the light is bad: video games and the future of assessment*, Madison: University of Wisconsin-Madison.  
<http://epistemicgames.org/eg/looking-where-the-light-is-bad>. Date of access: 21 February 2012.

Gee, J.P. 2004. *What Video Games have to Teach Us about Learning and Literacy*. New York: Palgrave Macmillan.

Gee, J.P. 2008. *Policy Brief: Getting Over the Slump: Innovation Strategies to Promote Children's Learning*. New York: The Joan Ganz Cooney Center.

Giddens, A. (Ed). 1974. *Positivism and sociology*. London, UK: Heinemann.

Gill, J. & Johnson, P. 2002. *Research methods for managers*, Sage.

Goede, R & de Villiers, C. 2003. Can grounded theory be used to determine whether IS practices reflect systems thinking methodologies? Paper presented at the 2003 Working Conference organised by Centre of Philosophy, Technology and Social Systems (CPTS), Maarssen, Holland, 29 April - 2 May 2003.

Goede, R., Taylor, E. & Van Aardt, C. 2013. Combining Research Paradigms to Improve Poor Student Performance. (*In: Pedro, I. & Miguel Baptista, N. eds. Information Systems Research and Exploring Social Artifacts: Approaches and Methodologies*. Hershey, PA, USA: IGI Global. p. 243-265)

Goulding, J., Nadim, W., Petridis, P. & Alshawi, M. 2012. Construction industry offsite production: A virtual reality interactive training environment prototype. *Advanced Engineering Informatics*, 26(1):103-116.

Greene, J.C., Caracelli, V.J. & Graham, W.F. 1989. Toward a conceptual framework for mixed-method evaluation designs. *Educational evaluation and policy analysis*, 11(3):255-274.

Greene, J. C. 2007. *Mixed methods in social inquiry*, John Wiley & Sons.

Gros, B. 2007. Digital Games in Education: the Design of Games Based Learning Environments. *Journal of Research on Technology in Education*, 40(1):23-39.

- Guba, E.G., & Lincoln, Y.S. 1989. Fourth generation evaluation. Thousand Oaks, CA: Sage.
- Guillén-Nieto, V. & Aleson-Carbonell, M. 2012. Serious games and learning effectiveness: The case of It's a Deal! *Computers & Education*, 58: 435-448.
- Gunter, G.A., Kenny, R.F. & Vick, E.H. 2008. Taking educational games seriously: using the RETAIN model to design endogenous fantasy into standalone educational games, *Education Tech Research Dev*, 56:511–537.
- Harteveld, C., & Bidarra, R. 2007. Learning with games in a professional environment: A case study of a serious game about levee inspection. *Proceedings of the 1st learning with games*, p. 555-562.
- Harteveld, C., Guimarães, R., Mayer, I. & Bidarra, R. 2007. Balancing Pedagogy, Game and Reality Components Within a Unique Serious Game for Training Levee Inspection. (*In Technologies for e-Learning and Digital Entertainment. Second International Conference, Edutainment 2007, Hong Kong, China, June 2007.* eds. Hui K., Pan Z., Chung R.C. & Jin X., Springer-Verlag Berlin Heidelberg, p. 128-139.
- Harteveld, C., Guimarães, R., Mayer, I. & Bidarra, R. 2010. Balancing Play, Meaning and Reality: The Design Philosophy of LEVEE PATROLLER. *Simulation & Gaming*, 41(3) 316–340. <http://sag.sagepub.com/content/41/3/316>. Date of access: 9 July 2012.
- Harvey, L. 1990. Critical social research. London, UK: Unwin Hyman.
- Heikkinen, H., Huttunen, R., & Syrjälä, L. 2007. Action research as narrative: five principles for validation. *Educational Action Research*, 15(1):5-19.
- Hoffman, D. 2010. Game design patterns rubric presented at GLS 6.0. <http://g4li.org/research?topic=Rubric>. Date of access: 19 February 2014.
- Hughes, J.A. 1990. The philosophy of social research. 2<sup>nd</sup> ed. London, UK: Longman.
- Hult, M. & Lennung, S. 1980. Towards A Definition of Action Research: A Note and Bibliography. *Journal of Management Studies*, 17:241-250.
- Jick, T.D. 1979. Mixing Qualitative and Quantitative Methods: Triangulation in Action. *Administrative Science Quarterly*, 24:602-611.
- Johnson, R.B. & Onwuegbuzie, A.J. 2004. Mixed methods research: A research paradigm whose time has come. *Educational researcher*, 33(7):14-26.
- Johnson, R.B., Onwuegbuzie, A.J., & Turner, L. 2007. Towards a definition of mixed method research. *Journal of mixed methods research*, 1:112-133.
- Jones, A., Scanlon, E., Tosunoglu, C., Ross, S., Butcher, P., Murphy, P., *et al.* 1996. Evaluating CAL at the Open University: 15 years on. *Computers in Education*, 26:5-15.

- Kadle, A. 2009. Do you need games in your e-learning mix? A white paper by Upside Learning Solutions. *Upside Learning Solutions* Bangalore, India. <http://www.upsidelearning.com/blog/index.php/2009/04/18/casual-and-serious-digital-gamesfor-learning-some-considerations/>. Date of access: 27 November 2014.
- Kaplan, B. & Duchon, D. 1988. Combining qualitative and quantitative methods in information systems research: a case study. *MIS Quarterly*, December 1988, 12(4):571-586.
- Klawe, M. & Phillips, E. 1995. A classroom study: Electronic games engage children as researchers. The first international conference on Computer support for collaborative learning, 1995. L. Erlbaum Associates Inc., 209-213.
- Klein, H.K. & Myers, M.D. 1999. A set of principles for conducting and evaluating interpretive field studies in information systems. *MIS Quarterly*, 23(1):67-94
- Kroeze, J.H. 2012a. Interpretivism in IS – a postmodernist (or postpositivist?) knowledge theory. *AMCIS 2012*.
- Kroeze, J.H. 2012b. Postmodernism, interpretivism, and formal ontologies. In *Research Methodologies, Innovations and Philosophies in Software Systems Engineering and Information Systems*, edited by Manuel Mora, OvseiGelman, AnetteSteenkamp, and Mahesh Raisinghani. Hershey PA: Information Science Reference (an import of IGI Global). p. 43-62.
- Kuhn, T.S. 1970. *The structure of scientific revolutions*. 2<sup>nd</sup> ed. Chicago, IL: University of Chicago press.
- Kuhn, T.S. 1977. *The essential tension: Selected studies in scientific tradition and change*. Chicago, IL: University of Chicago Press.
- Lee, A.S. 1999. Researching MIS. (In Currie, W.L., & Galliers, R. *Rethinking Management Information Systems*. Oxford, UK:Oxford University Press. p. 7-27)
- Lenhart, A. & Kahne, J. 2008. Teens, video games and civics. Pew Internet and American Life Project. [www.pewinternet.org/Reports/2008/Teens-Video-Games-and-Civics.aspx](http://www.pewinternet.org/Reports/2008/Teens-Video-Games-and-Civics.aspx). Date of access: 27 November 2014.
- Lindley, C.A. 2004. Narrative, game play, and alternative time structures for virtual environments. (In Gobel, S., Spierling, U., Hoffman, A., Iurgel, I. Schneider, O Dechau, J. & Feix, A. eds. *Lecture Notes in Computer Science: Technologies for Interactive Digital Storytelling and Entertainment*. Heidelberg: Springer Berlin. 3105:183-194).
- Locke, L.F., Silverman, S.J. & Spirduso, W.W. 2010. *Reading and Understanding Research*, United States of America, SAGE Publications, Inc.
- Mayo, M.J. 2007. Games for science and engineering education. *Commun. ACM*, 50:30-35.
- Micheal, D. & Chen, S. 2006. Serious games: Games that educate, train, and

- transform. Boston, MA. Thomson Course Technology.
- Mingers, J. & Brocklesby, J. 1997. Multimethodology: Towards a framework for mixing methodologies. *Omega* 25:489–509.
- Mingers, J. 2001. Combining IS research methods: Towards a pluralist methodology. *Information system research*. p. 240-259.
- Mouton, J. 2001. *Methodological paradigms in social research. The practice of social research. South African Edition.* Cape Town: Oxford University Press.
- Myers, M.D. & Avison, D. 2002. *Qualitative Research in Information Systems: A Reader*, SAGE Publications.
- Myers, M.D. 1997. Qualitative research in information systems. *Management Information Systems Quarterly*. p. 241-242.
- Myers, M.D. 2008. *Qualitative Research in Business & Management* SAGE Publications.
- Myers, M.D. 2009. *Qualitative research in business & management*, Los Angeles; London, Sage.
- Neuman, W.L. 2011. *Social Research Methods: Qualitative and quantitative approaches.* Boston, MA:Pearson Education.
- Oates, B.J. 2006. *Researching information systems and computing.* London, UK: SAGE Publications.
- Oliver, M. 2000. An introduction to the evaluation of learning technology. *Educational Technology & Society*, 3:20-30.
- Pather, S. & Remenyi, D. 2005. Some of the philosophical issues underpinning research in information systems - from positivism to critical realism: reviewed article. *South African Computer Journal*, p. 76-83.
- Prensky, M. 2001. *Digital Game-Based Learning*, New York, McGraw-Hill.
- Rieber, Smith, & Noah. 1998. The value of serious play. *Educational Technology-Saddle Brook NJ*, 38:29-36.
- Robertson, J. 2012. Making games in the classroom: Benefits and gender concerns. *Computers & Education*, 59(2012), Elsevier.
- Salen, K. & Zimmerman, E. 2003. *Rules of Play: Game Design Fundamentals*, The MIT Press.
- Saunders, M., Lewis, P. & Thornhill, A. 2009. *Research methods for business students.* 5th ed. Harlow: Pearson.
- Sawyer, B. & Smith, P. 2008. Serious games taxonomy. <http://www.dmill.com/presentations/serious-games-taxonomy-2008.pdf>. Date of access: 27

November 2014.

Schutz, A. 1962. *Collected papers: The problem of social reality*. Volume I, Springer.

Shaffer, D.W., Halverson, R., Squire, K.R. & Gee, J.P. 2005. *Video Games and the Future of Learning*. WCER Working Paper No. 2005-4. Wisconsin Center for Education Research (NJ1).

Sieber, S.D. 1973. The integration of fieldwork and survey methods. *American journal of sociology*:1335-1359.

Šisler, V. & Brom, C. 2008. Designing an educational game: Case study of Europe 2045'. *Transactions on edutainment I*. Springer.

Smith, R.D. 2008. Five forces driving game technology adoption. The Interservice/Industry Training, Simulation & Education Conference (I/ITSEC).

Squires, D. & Mcdougall, A. 1994. *Choosing and using educational software: a teacher's guide*. Psychology Press.

Squire, K. 2005. Changing the game: what happens when video games enter the classroom. *Innovate: Journal of online education*, 1(6).

Squire, K. 2006. From Content to Context: Video games as Designed Experiences. *Educational Researcher*, 35(8), 19-29.

Strauss, A. & Corbin, J.M. 1998. *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*, SAGE Publications.

Susman, G. & Evered, R. 1978. An Assessment of The Scientific Merits of Action Research, *Administrative Science Quarterly*, 23(4):582-603.

Symonds, J.E., & Gorard, S. 2010. Death of mixed models? Or the rebirth of research as a craft. *Evaluation and Research in Education*, 23(2):121-136.

Teddlie, C. & Tashakkori, A. 2009. *Foundations of Mixed Methods Research: Integrating Quantitative and Qualitative Approaches in the Social and Behavioral Sciences*, SAGE Publications.

Ulicsak, M. & Wright, M. 2010. Games in education: serious games. A Futurelab literature review. Futurelab, 1 Canons Road, Harbourside, Bristol BS1 5UH, United Kingdom, June.

[http://media.futurelab.org.uk/resources/documents/lit\\_reviews/Serious-Games\\_Review.pdf](http://media.futurelab.org.uk/resources/documents/lit_reviews/Serious-Games_Review.pdf). Date of access: 27 November 2014.

Van Eck, R. 2006. Digital game-based learning: It's not just the digital natives who are restless. *EDUCAUSE review*, 41(2):16.

Vanden Abeele, V., De Schutter, B., Geurts, L., Desmet, S., Wauters, J., Husson, J., Van Audenaeren, L. & Van Broeckhoven, F. 2011. pimi – A framework for serious game development. [https://www.academia.edu/1197871/PIII\\_-](https://www.academia.edu/1197871/PIII_-)

\_A\_framework\_for\_serious\_game\_development. Date of access: 27 November 2014.

Vogel, J.J., Vogel, D.S., Cannon-Bowers, J., Bowers, C.A., Muse, K., & Wright, M. 2006. Computer gaming and interactive simulations for learning: A meta-analysis. *Journal of Education Computing Research*, 34:229-243.

Warmington, A. 1980. Action Research: Its Method and Its Implications. *Journal of Applied Systems Analysis*, 7(4):23-39.

Wessels, E. 2014. *Towards a conceptual decision support systems framework aimed at narrowing the tax gap in South Africa: a narrative case study*. University of South Africa.

Westera, W., Nadolski, R.J., Hummel, H.G.K. & Wopereis, I.G.J.H. 2008. Serious games for higher education: a framework for reducing design complexity. *Journal of Computer Assisted Learning*, 24:420–432

Wouters, P., Van Der Spek, E.D. & Van Oostendorp, H. 2009. Current practices in serious game research: a review from a learning outcomes perspective. *Games-based learning advancements for multisensory human computer interfaces: techniques and effective practices*:232-255.

Wrzesien, M. & Alcañiz Raya, M. 2010. Learning in serious virtual worlds: Evaluation of learning effectiveness and appeal to students in the E-Junior project. *Computers & Education*, 55(1):178-187.

Younis, B. & Loh, C. 2010. Integrating serious games in higher education programs. Proceedings of the academic colloquium 2010: Building partnership in teaching excellence.

Zyda, M. 2005. From visual simulation to virtual reality to games. *Computer*, 38(9):25-32.