CHAPTER 4
DESIGN NOTES ON THE USE OF A COMPUTER GAME AS A TEACHING TOOL

4.1 INTRODUCTION

In the previous chapter, an overview of the findings on previous research conducted on the use of experiential teaching methodologies was given. The pedagogical considerations to take into account when designing an experiential educational aid was summarised from this literature. In this chapter, literature on the use of computer games as teaching tools is reviewed in order to identify considerations specifically regarding computer games, which were taken into account for the design of the game used in the current study.

In the following chapter, design principles, which include pedagogical and game-specific principles, are reviewed. The different types of games are presented, which helped to obtain insight into the various design possibilities. Specific considerations that needed to be taken into account (as evident from the literature review) in terms of the game design and the goals of the game are summarised accordingly.

4.2 DESIGN PRINCIPLES

Ramsden (1993) noted that practical demonstrations are very difficult to connect back to a theoretical base. This indicates that the link between theory and any experiential educational material used to enhance the teaching of the theory is both difficult to establish and a necessity. Therefore, the dimensions of educational goals and gameplay should be balanced in order to achieve a meaningful entity – a view also supported by Kiili (2007).

The following paragraphs therefore focus on the design principles that were taken into account in the design of the educational computer game, both from a pedagogical and a gameplay perspective.
4.2.1 Pedagogy

Some research has been done on the establishment of pedagogical foundations as a basis for educational game design (Kiili, 2007; Squire, 2002). Kiili (2007) acted on the lack of educational game research by developing and testing an empirically allocated model that can be utilised for the design of pedagogically meaningful games. The proposed model was evaluated through a business simulation game. The semi-structured interviews conducted by Kiili (2007) indicated that authenticity, collaboration and learning by doing were the most important characteristics of effective educational games, yet an examination of typical educational games indicates that they resemble digital exercise books too much and do not utilise the power of games as an interactive context-free media. Kiili (2007), as supported by the research of Kiili (2005b) and Moreno and Mayer (2005) also notes that the reason for this is that there is a lack of research that focuses on game designs that foster knowledge construction, deeper understanding and problem solving, while being engaging and entertaining at the same time.

4.2.1.1 Experiential learning as a pedagogical foundation for education computer game design

The ideology of active (experiential) learning provides a fruitful basis for the integration of gameplay and pedagogy. Experiential learning (as discussed in Chapter 3) advocates that students be active participants in the learning process and the computer game environment could be designed as the perfect milieu for them to do just that. Because games usually allow players to creatively test hypotheses and reflect on outcomes in the game world, experiential learning theory provides an appropriate basis for PBL (Drake, 2011). Although the educational game will contain elements of basically all experiential methods, including the case study, simulation and role-play methods, it seems that previous research on the integration of pedagogy and gameplay has focused mainly on PBL methods as a suitable pedagogical undertone for the structure of meaningful game design (Drake, 2011 Kiili, 2007).

It seems that the main principles of PBL – contextuality, collaboration and experientialism (Boud & Feletti, 1991) – can also form the foundation of educational games and from this theory an adaptation of problem learning stems, namely the problem-based gaming method. It is thought that games provide a meaningful framework for offering problems to students. In fact, a game itself is a big problem that is composed of smaller casually linked problems (Kiili, 2007). As students are confronted with these problems, learning occurs
through a construction of cognitive structures through action (learning by doing) in the game world (Kirriemuir, 2002).

The basic idea is to anchor the learning of knowledge and skills into meaningful problem-solving situations encountered in everyday work life. This type of approach underscores the transferability of theoretical knowledge and learned skills into practice (Savery & Duffy, 1995).

The game’s storyline and the game world are therefore used to create a simulated context-specific reality to offer authentic problems to students. The students then have to use creative and comprehensive problem solving in order to endeavour to test different kinds of strategies, enabling them to expand knowledge on the subject matter and optimise playing strategy to solve the problems and so complete the game.

### 4.2.1.2 Key pedagogical elements to be addressed by the computer game design

Although problem-based gaming was the main pedagogical foundation for the educational game design, research conducted on the use of other closely related active learning methods also provided valuable pedagogical principles that were taken into account in the educational game design. The purpose of this was to enhance the pedagogical problem-based gaming foundations of the educational computer game.

One of the methods closely related to the educational computer game method is the case method (refer to Section 2.3.2 in Chapter 2), in which students are also confronted with a problem that they have to solve in order to complete the case study. Biggs (1989) identified four key elements in fostering a deeper approach to learning with case studies. The key elements are motivation, student activity, interaction with others and a well-structured knowledge base. Each of these is discussed in the following sections.

#### 4.2.1.2.1 Motivation

Students need to be motivated in order to maximise the active learning experience. Biggs (1989) suggests that motivation could be fostered by involving students in what is to be learnt (goal setting and communication). The emotional climate of learning also has to be regulated. Students need to be intrigued with and emotionally involved in the scenario, but not frustrated. These factors can be manipulated by including an element of competition (Waddell & McChlery, 2008), guidance in the experience and stimulating student interest by using real-world scenarios (realism). Guidance could be given in the form of a facilitator.
or textbook, or could be pre-programmed into the design of the game. Realism could be enhanced by including demonstrations of real-world ambiguities, moral considerations and complexities in decision making in the game.

4.2.1.2.2 Student activity

Hendricks (1987) refers to meaningful activity as activity that:

- provides direction without dictation;
- is induced by what the student, and not the lecturer, wants to learn;
- is supported by previous knowledge taught to the student;
- has a planned purpose and outcomes;
- is realistic; and
- includes problem-solving situations.

Student activity should also be more active than passive. Biggs (1989) recommends that students should be involved in planning, reflection, processing and relation to abstract concepts. This is consistent with the different stages in Kolb’s learning cycle, which includes concrete experience, reflective observation, abstract conceptualisation and active experimentation (Kolb & Kolb, 2005).

In terms of game design, this means that the game should be programmed to provide an opportunity for the student to experience and engage each of these steps in the learning cycle. The game should include an introduction to a real audit scenario (concrete experience), a chance to interact with and think about the experience in relation to the theoretical concepts (reflective observation), a tutorial on the concepts illustrated in the scenario (abstract conceptualisation) and a chance to test knowledge in the form of a challenge/test (active experimentation). This cycle can be repeated if the student cannot pass the final challenge/test, and the cycle should be repeated for each stage of the game.

This should lead students to having to develop processes unique to each case, such as the ability to exercise judgement based on a given scenario, as advocated by Biggs (1989).
4.2.1.2.3 Interaction with others

It is important to note that gaming cannot be considered as either an individual or a social activity, because games can consist of both individual and social events (Kiili, 2007). The social aspects of the game can also be either simulated (socialisation with pre-programmed characters or tutors in the game) or real (socialisation with team players or adversaries).

Biggs (1989) advocates at least some interaction with others. Some of the possibilities that could be included in the game design in order to facilitate interaction with others are the following:

- Integration of a chat function in the game
- Local area network (LAN) gaming
- Online gaming
- Dividing student into teams with only one terminal per team
- Discussion boards
- Meetings with students
- Gaming in a class environment where students can consult with each other while the lecturer acts as facilitator
- Integration of animated characters or tutors within the game.

4.2.1.2.4 A well-structured knowledge base

The technical content of the experiential method should be linked to the previously learned theoretical base of the subject at hand (Hendricks, 1987). The students should have a well-structured knowledge base that provides them with all the necessary essential technical information to solve the problems in the game. The game therefore serves as a vehicle for providing scenarios to show the students how technical knowledge is used in operations in the real world. In this way, their previous technical knowledge is strengthened and students gain an understanding of why they are being taught the technical theories, concepts and principles.
4.2.1.3 **Writing good problems**

There is a need for substantial cases that confront students with a dynamic and not straightforward situation in order to develop their critical thinking and problem-solving skills. Milne and McConnel (2001) note that a key consideration during the implementation of PBL should be the availability of good problems, as these are scarce, while Hansen (2006) consistently suggests that the biggest challenge regarding the implementation of PBL is the writing of good problems. It is suggested that a case study taking the student through all the stages of an audit, from planning to audit opinion, would be a valuable contribution to educational material (Maltby, 2001).

4.2.1.3.1 **The writing process**

Case studies have to adhere to proper planning in terms of which aims and objectives of the course and the broader professional perspectives will be addressed, else their power to achieve and assess important learning outcomes could be wasted (Hassall et al., 1998). The case question therefore has to be written or integrated in the course in such a way as to adhere to the specific pre-set learning outcomes the lecturer wishes the students to achieve.

There are two possibilities when designing cases: inventing a situation, or drawing on a real one. There are advantages and disadvantages to both methods.

An invented case can both introduce a student to the audit techniques available and point out the limitations and problems inherent to them. The case can be tailored to the specific learning outcomes that the lecturer wishes the students to achieve. However, all invented cases may have the limitation that they tend to be rigidly structured. Rigidly structured cases tend to steer the reader too dramatically towards a single pre-determined answer. This is especially true when the solution is designed before the case. The ambiguity of the real world of audit practice is therefore not communicated to the students and could give the students a false sense of certainty not available to the professional auditor in public practice. Although this type of case may be appropriate as an aid to training, it is not effective in encouraging students to deal with complexity and ambiguity in problem solving. The lecturer could still attempt to invent a case that incorporates the above-mentioned elements, but previous research has shown that it is very difficult to invent a case that has the richness and complexity of a real-life situation (Maltby, 2001).

When following the approach of inventing a case study, Wilkinson (1992) gives the following guidelines to make the content applicable:
Another approach to writing case studies is the approach where the case study is based on a real-life situation. An example of this is the ‘living case’ approach followed by Drake (2011). This approach uses corporate failure stories from the media as an example to foster critical appraisal of the audit practice among students. This approach is a way of getting students to appreciate the role of the professional auditor in public practice, illustrating the relevance of theoretical concepts and introducing students to the ambiguity and problem-solving skills required of an auditor in practice. Some drawbacks of this method include that corporate failure stories are not always publicly available, as client confidentiality has to be taken into account, and that the case may not always address the learning outcomes covered in the course. The situation might also be so complicated and intrinsically complex that the students do not have the skill level to understand the situation and therefore are not able to link the theory to the practical situation.

4.2.1.3.2 Authenticity

The authenticity of learning situations and tasks is assumed to be a very important factor in facilitating higher-order learning (Brown, Collins, & Duguid, 1989), at least in tertiary education. Students need to be able to relate to the situation and picture themselves in a similar work situation in order for them to be able to contextualise the learning experience, as also confirmed by Drake (2011). Players of educational games also regard authenticity as a very important element in educational games; however, they realise that it is not reasonable to simulate the real world too precisely. It is obvious that some simplifications to reality have to be made in order to achieve simulated reality in which educational experiences can take place.

The authenticity of the answer should also be taken into account, as in practice, most scenarios do not have a single correct solution and answers could be ambiguous. In a study conducted by Waddel and McChlery (2009), the case study offered multiple solutions and students agreed that this was a positive aspect. However, care has to be
taken to ensure that students do not become frustrated with or confused by the fact that case studies have no ‘correct’ answer.

The environment, story and answer may therefore be simplified reality, but it is important that the auditing process and context of the auditing process are viewed as authentic and realistic. Gray and Manson (2008) observed through teaching in both undergraduate and professional courses that students are more engaged by teaching methods that contextualise the auditing process as opposed to separate lectures that segregate this process into singular themes.

4.2.1.3.3 Role play

When writing the case study, it has to be taken into account whether or not the case should be adaptable for role play or not. The effect of role-playing is to make students assume the viewpoint of a particular party to the audit – such as the audit partner or article training clerk – and work out what that individual’s interests and motives would be. This is a way of getting students to appreciate the ‘messiness’ of audit in practice and draws the student into the situation as an active participant. The student is also more likely to become emotionally involved in the situation and will find it easier to relate to the situation. This approach may lead students to appreciate the nature of the interests of the various parties involved in the audit and throw a new light on the need for the auditor to have adequate technical, professional and legal resources and to maintain objectivity and independence (Maltby, 2001). There is the possibility of computerising the role-play function through an animated storyboard that assumes the players to be one of the characters.

4.2.1.3.4 Problem-based learning

It is important to note that at the heart of all good problems lies the pedagogy of PBL. Therefore, the rules of this pedagogy should be adhered to when writing good problems in order to reap the benefits of this teaching methodology (as discussed in Section 2.3.3.1 in Chapter 2). The problem should be written in such a way that it is the catalyst that stimulates students to acquire new knowledge (Milne & McConnel, 2001). The problem should be complex and realistic to some extent (Hansen, 2006). Charles Hatting, for example (a well-known accountancy course presenter in South Africa), consistently makes use of his practical real-life experience when teaching a topic or stimulating a conversation among students. Students must also be guided through the problem-solving process and careful consideration should be given to the form of assessment, as students
will behave in line with the assessment criteria, whether these support the problem-solving learning activity or not (Milne & McConnel, 2001). Friedlan (1995) also states that assessment is a crucial criterion that needs to be addressed in order to ensure the success of any experiential method of teaching.

4.2.1.3.5 Other key and administrative considerations

Other factors to consider during the writing of the case problem include the following (Knapp, 1996; Waddell & McChlery, 2009):

- The challenge in writing a good problem is to encourage students to think through the auditing process, without giving too much of the answer away.
- It must be possible to integrate the case with other teaching materials on the topic.
- The case has to be integrated with theoretical aspects.
- The case has to deepen the students’ understanding of theoretical aspects.
- It must be presented in such a way that the student is drawn into the situation as a participant.
- The problem must be resolvable.
- The case study must be credible to the degree that the student views it as an actual occurrence or a situation that in all probability will occur.
- The issue of time constraints will determine the amount of technical material that can be covered by the case.

4.2.1.4 Summary

From the above review, it can be determined that the following factors need to be considered in order to write a case problem with a strong pedagogical foundation:

- Students should be motivated by including one of the following elements: competition, goal setting, communication, realism, guidance and/or an environment in which students can become interested or emotionally involved.
- Student activity should be meaningful and centred around what the students would want to learn from the given scenario.
- Student activity should be planned to include stages of concrete experience, reflective observation, abstract conceptualisation and active experimentation.
• Some form of interaction with others should be included through interaction with the lecturer, classmates and/or animated pre-programmed characters.

• The technical content of the question should be linked to previous theoretical knowledge acquired by the student.

• The lecturer should choose to either invent a case study or draw on a real problem, taking into account the various advantages and disadvantages of both methods (as discussed in Section 4.2.1.3.1).

• Whether invented or adapted from a real situation, the case should be authentic to the extent of being described as simplified reality.

• The lecturer has to choose whether the case study will be adaptable to role play or not, for example through role play by virtual or real characters.

• The problem should be the catalyst for students to develop a desire to achieve the learning outcomes of the scenario.

• The difficulty of the scenario should be tailored to the optimal level of complexity.

• Students must be guided throughout the problem-solving process.

In conclusion, it is important that the game should have a strong pedagogical foundation. In this study, the game was based on the theory of active learning (experiential theory) and specific educational objectives were established accordingly before the writing of the case problem commenced. The question and memorandum were then written specifically to accomplish these goals. It is important to note that the amount of technical material chosen to be included in the educational game was largely determined by the time constraints placed on the project, but the aim was still to give the students at least some idea of how the audit process functions and how the technical theory integrates with this process.

4.2.2 Gameplay

After the pedagogical foundations had been laid, the packaging of the educational material had to be decided upon. This involved gameplay considerations. An educational game has to strike a balance between educational and gameplay content. According to Costkyan (2002), good gameplay keeps a player motivated and engaged throughout the entire game. While the educational content is the core of the game, the gameplay is the
vehicle to get the student there and neither of these elements should be neglected. The core of the educational game, which sets it aside from other experiential teaching methods (as discussed in Chapter 2), is the process of playing the game. Therefore, the significance of this process of play should not be underestimated (Kebritchi & Hirumi, 2008).

4.2.2.1 Definition of gameplay

Gameplay encompasses the process that students go through in order to complete the game. It consists of interactive as well as non-interactive elements and aims to draw the player into the game as an active participant.

The aim of educational gameplay is to provide a simulated environment with which players can experiment. They should try to come up with different strategies to win the game. The feedback they receive guides them in this process. Unfortunately, some games have been used in education primarily as tools for supporting the practice of factual information. The nature of action-based drill and practice games may lead to behaviour where players tend to try actions with no reflection on the outcomes. In such games, players may simply keep on experimenting with actions until their scores improve. However, such behaviour, based only on trial and error, does not enhance learning (Kebritchi & Hirumi, 2008).

4.2.2.2 Game flow

Research suggests that games are most successful when they facilitate the flow experience (Kiili, 2007). The flow experienced was first noted in research by Csikszentmihalyi (1975), who observed people who found themselves in an optimal psychological state of absorption or engagement while engaged in goal-driven activities such as rock climbing, chess and dance. Later research describes a positive correlation between the flow experience and behaviour such as learning, exploring (Webster, Trevino, & Ryan, 1993). Therefore, recreation of ‘the flow experience’ should be taken into account when designing an educational game.

According to Kiili (2005a), the likelihood of experience flow is dependent on the interplay between the person, the task and the artefact (tools or toys). Experience flow can be enhanced by including the following elements in the game:
• A clear set of goals (Kiili, 2005a)
• Immediate and appropriate feedback (Chen, Wigand, & Nilan, 1999)
• Potential control (Finneran & Zhang, 2003)
• A perception of challenges that are matched to the person’s skills (Chen et al., 1999)
• Playfulness (Webster et al., 1993)
• Speed and ease of use of user interfaces (usability) (Skadberg & Kimmel, 2004).

### 4.2.2.3 Usability

The concept of usability is derived mainly from the fact that the processing capacity of the working memory is limited (Brunken, Plass, & Leutner, 2003). Therefore, a complex task should not be combined with an artefact (in this study, the game) that is complex to control and use, as this will detract from the educational value of the game (Pearce & Howard, 2004). Because auditing is already a complicated subject to comprehend, it is especially important to design a game with good usability. It is ideal that all possible resources be available for relevant information processing of the educational aspects of the game and that they are not wasted on comprehending the tools of the game. This means that the user and game interfaces have to be transparent and easy to use. Good usability allows the player to focus on higher-order tasks, while poor usability decreases the likelihood of experiencing flow, because the player has to sacrifice attention and other cognitive resources to inappropriate activities.

### 4.2.2.4 Skill level

A good game should be easy to learn, yet difficult to master. It is important that the challenges in the game are linked to the player’s skill level (Kiili, 2005a). When the challenges are on par with the player’s skill level, learning, motivation and engagement are optimised. Educational games, especially, should be balanced so that the main determining factor for the success of a player is the player’s skill level. If the challenge is significantly greater than the player’s skill level, he or she may experience frustration and anxiety. In contrast, if the challenge is significantly lower than the player’s skill level, the player may become bored or feel that the game is a waste of time. The skill level required of the player can be set by pre-determining the educational outcomes of the game, but within these parameters there still needs to be allowance for players with higher- and
lower-level skills. This can be addressed by including personalised feedback, tutorials and hints within the game itself, which will serve to aid the individual’s progress through the game. This thought process is supported by Ebner and Holzinger (2002).

4.2.2.5 Storytelling

The story contextualises the simulated environment and provides the opportunity to task students with certain educational activities, which ultimately leads them to solving the larger task or problem (Seagram & Amory, 2004). It also serves to engage and immerse the player and could be educative as well.

The story and tasks are integrated by dividing the game into interactive gameplay events and non-interactive story events. The non-interactive elements are usually implemented by introducing animated content (Moreno & Mayer, 2005) and should ideally give the player of the game the information he or she needs to successfully complete the interactive gameplay events (Kiili, 2005a).

When making use of animations, care has to be taken, as animations in gameplay are often too complex or too fast to be accurately perceived and continuous events are also often conceived as sequences of individual steps (Ebner & Holzinger, 2002). The auditing process may for example be perceived as individual unrelated tasks instead of a continuous process. Careful use of interactivity can overcome these disadvantages (Schnotz, Böckheler, & Grzondziel, 1999). Care should also be taken not to include too many non-interactive elements in the game, as students tend to consider interactivity in gameplay as extremely important (Holzinger & Ebner, 2003; Kozma, 1991).

Malone (1980) summarised three essential characteristics for computer games to answer the question of what makes a computer application enjoyable to operate, namely challenge, curiosity and fantasy. This is largely consistent with the elements that various modern researchers, such as Kiili (2007), Holzinger and Ebner (2003), Squire (2002) and Marriott (2004), advocate. The story therefore needs to make room for these three elements by creating a challenge relevant to the student’s skill level, provoking the curiosity of the student through exciting storytelling and incorporating some kind of fantasy (as fantasy is usually more interesting and dramatic than reality). Fantasy in storytelling can be very important in creating intrinsically motivating environments. However, these must be carefully chosen to appeal to the target audience. The students still need to be able to relate to the story in some way and, as noted before, the scenario has to be realistic enough to be educational. The student needs to be motivated to achieve the
goals of the game, which should, in turn, lead the student to achieving the educational outcomes of the gaming experience.

### 4.2.2.6 Types of games

Kebritchi and Hirumi (2008) examined the pedagogical foundations of modern educational (computer video) games. They studied the design and pedagogical foundations of a number of modern educational computer games and ultimately contributed a summary of the different types of educational games that have scientific pedagogy underpinning their design. They established that there are different types of approaches one can take to develop an educational game. Eight instructional strategies rooted in the concept of learning through gaming were identified. The eight instructional strategies are (a) a direct instructional approach, (b) experiential learning, (c) guided experiential learning, (d) learning by doing, (e) a case method teaching combination, (f) inquiry-based learning, (g) discovery-based learning and (h) guided inquiry and discovery-based learning. A short summary of the main principles of the different learning strategies on which the game type could be based, adapted by the researcher based on the work of Kebritchi and Hirumi (2008), is given below:

- **Direct instructional approach**

  The direct instructional approach is associated with action drill and practice games. The game will usually introduce a new concept and then give the student a chance to practise said newly learned concepts. Students are given feedback on their answers immediately. This approach is underpinned by the behaviourist learning theory, which suggests that learning occurs through stimulus response conditioning and generates and sustains motivation through pacing and reinforcement (Hirumi, 2005). These types of games are usually implemented in the field of mathematics.

- **Experiential learning**

  During experiential learning, students are purposefully engaged in direct ‘real-life’ experiences. They receive feedback on these experiences and learning occurs during reflection on these experiences (Wood Daudelin, 1997). The active learning theory is grounded in the belief that experience occurs as a result of interaction between human beings and the environment in the forms of thinking, seeing, feeling, handling and doing (Kebritchi & Hirumi, 2008). It has since been found that this experience may take place equally in real or artificial environments (Kebritchi & Hirumi, 2008). As stated by Egenfeldt-
Nielsen (2005, p. 125), “[i]n today’s computer games you are part of a living, breathing, simulated universe with very concrete self-sustaining experiences – getting still closer to reality”. Knowledge is therefore constructed as a result of experiencing and interacting with the simulated environment. Various authors have attempted to integrate experiential learning in both traditional type lectures and educational game design (Appelman, 2005; Fouché, 2006; Kiili, 2005a).

- **Guided experiential learning**

Guided experiential learning is based on the experiential learning theory, but also incorporates guidance. In addition to providing the experiences of unguided experiential learning, guided experiential games also provide lessons with goals, reasons, concepts, processes and procedures. In a study by Clark (2005), it was reported that guided experiential learning was found more effective than an unguided experiential learning strategy, as the amount of learning increased and the learning time decreased.

- **Learning by doing**

The primary goal of learning by doing is to foster skill development and the learning of factual information in the context of how it will be used. It is based on the assumption that learning occurs best in the context of a goal that is relevant, meaningful and interesting to students. Typically, players will be confronted with a situation that they might experience one day in the workplace and are required to act accordingly to solve a problem or complete a challenge. These types of games are usually used effectively in the civil engineering and medical fields (Squire, 2001, 2002).

- **Case method teaching**

Case method teaching provides trainees with opportunities to analyse knowledge within rich and realistic, but largely fictitious, stories. Hill, Gordon and Kim (2004, p. 3) describe it as follows: “A case is a synopsis of the experiences, decisions and actions of others that can be studied and provide a vicarious learning experience by placing the student in the shoes of another”. Students are presented with historical or invented case stories, which provide opportunities for the trainees to explore alternative ways to fix the problems. Students are guided by the game functions to further refine their alternative solutions. The last stage in this learning process is where students are granted the opportunity to reflect on their learning experiences.
• **Inquiry-based learning**

Inquiry-based learning promotes inquiry strategies and values, such as process skills (observing, collecting and organising data), active learning, verbal expression, tolerance of ambiguity and logical thinking. This is achieved by drawing students’ minds away from memorising facts and towards inquiring about facts and concepts in order to solve a problem that they are confronted with. In this way, students learn through analysing hands-on and real-world-related activities (Barab, Thomas, Dodge, Carteaux, & Tuzun, 2005).

• **Discovery-based learning**

During discovery-based learning, students are expected to interact with and explore the learning environment. Actions include manipulating objects, conducting experiments and wrestling with questions and controversies (Ormrod, 1995). Students then experience the results of their actions and learn from this. The idea is that students are more likely to remember concepts that they discover on their own. It has been discovered that discovery-based learning is most effective when the students’ experiences are structured and the students have some prerequisite knowledge (Kebritchi & Hirumi, 2008).

• **Guided discovery and inquiry-based learning**

Guided discovery and inquiry-based learning is similar to unguided discovery and inquiry-based learning, except that it includes guidance such as tutorials, mini-tutorials, hints and tips and other integrated educational material. In this way, the students’ discovery of the environment or inquiry of facts is still spontaneous, but guided in a more structured experience that enhances the educational value of the experience (Kebritchi & Hirumi, 2008).

### 4.2.3 SUMMARY

From the above review, the advantages/key aspects of each type of educational game can be summarised as follows:
<table>
<thead>
<tr>
<th>GAME TYPE</th>
<th>ADVANTAGES/KEY ASPECTS</th>
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<tbody>
<tr>
<td>Direct instructional approach</td>
<td>• Students learn through repetitive conditioning</td>
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<td></td>
<td>• Students receive immediate feedback on their actions</td>
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<td></td>
<td>• Motivation stems from pacing and reinforcement</td>
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<td></td>
<td>• Most commonly used in the field of mathematics</td>
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<tr>
<td>Experiential learning</td>
<td>• Students experience real-life situations in a simulated universe</td>
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<td></td>
<td>• Learning occurs through stages of reflection on experiences and feedback</td>
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<tr>
<td></td>
<td>• Is widely used in a variety of subjects and fields</td>
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<tr>
<td>Guided experiential learning</td>
<td>• Based on the experiential learning method</td>
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<tr>
<td></td>
<td>• Additionally includes goals, reasons, concepts, processes and procedures</td>
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<td></td>
<td>• Aim is to increase the effectiveness of normal experiential learning by increasing the amount of learning and decreasing the learning time</td>
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<tr>
<td>Learning by doing</td>
<td>• Students are confronted with an experience similar to one which they can expect to experience in the workplace after their studies</td>
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<td></td>
<td>• A key focus is the development of skills</td>
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<tr>
<td></td>
<td>• Learning occurs in the context of a relevant, meaningful and interesting goal</td>
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<tr>
<td></td>
<td>• Commonly used in the fields of civil engineering and medicine</td>
</tr>
</tbody>
</table>
## Case method teaching
- Students are confronted with a rich, realistic, largely fictitious story, which can be historical or invented
- The game guides students to refine alternative solutions
- Also includes a stage of reflection

## Inquiry-based learning
- Students learn through analysing real-world activities
- Students are expected to perform inquiry procedures in order to solve a problem
- Discourages learning theory by heart

## Discovery-based learning
- Student activity includes exploration of a simulated learning environment
- Learning occurs through students experiencing the results of their actions
- Retention of knowledge is higher because students discover knowledge
- Prior knowledge is a prerequisite

## Guided discovery and inquiry-based learning
- Based on normal discovery and inquiry-based learning
- Additionally includes guidance, tutorials, mini-tutorials, hints, tips and other integrated educational material
- Aim is to retain spontaneity, but enhance educational value
Eight different educational game types have been identified and the main principles of each reviewed. It has also been noted that that student-centred instructional strategies such as discovery learning, problem-based solving, experiential learning and inquiry-based strategies did not work effectively unless additional guidance was provided for novice, intermediate and high-achieving students (Kirschner, Sweller, & Clark, 2006; Mayer, 2004). This coincides with the notion that guided experiential strategies are suggested to be more effective than unguided experiential strategies (Clark, 2005). Kebritchi and Hirumi (2008) also noted that games with student-centred approaches are more effective and attractive to students than games with basic drill and practice approaches.

Experiential learning theory is perhaps the educational theory that has been utilised most frequently as a pedagogical foundation for educational games. The different active learning methods that stem from this theory have also been used extensively in accounting education, and to a lesser extent in auditing education.

Taking all of these factors into account, it was decided that the educational game to be used in auditing education for this study would also be of the experiential type. As guided experiential learning was also suggested to be more effective than unguided experiential learning, it was decided that guidance would be included in the game through interface design, hints, mini-tutorials and a gradebook function. The overall objectives of the game were established accordingly.

**4.3 GOALS OF THE EDUCATIONAL COMPUTER GAME**

By drawing from the research done in the literature review, the overall goals of the project of developing an educational computer game to be used as an aid in auditing education were established as follows:
<table>
<thead>
<tr>
<th>NO.</th>
<th>OVERALL GOALS OF THE EDUCATIONAL COMPUTER GAME</th>
<th>PARAGRAPHS IN THIS STUDY THAT GIVE RISE TO THE OVERALL GOAL</th>
</tr>
</thead>
</table>
| 1   | Engage the students and make the learning content seem less boring and more interesting to the future auditors | Chapter 1.3.4 Inherent reasons why students struggle with Auditing as a theoretical subject  
Chapter 2.2 Experiential teaching methodology  
Chapter 2.3.7.1 Educational games – Potential benefits  
Chapter 3.3.1.2 Case studies – Auditing education  
Chapter 3.3.2.2 Simulations – Auditing education |
| 2   | Aid the students in developing an understanding of the relatedness of the various elements of the curriculum | Chapter 1.3.4 Inherent reasons why students struggle with Auditing as a theoretical subject  
Chapter 1.3.5 Criticism of traditional auditing education  
Chapter 2.3.5.1 Simulations – Potential benefits |
| 3   | Add some type of simulated practical exposure to the academic programme | Chapter 1.3.5 Criticism of traditional auditing education  
Chapter 2.3.5.1 Simulations – Potential benefits |
| 4   | Help students see the big picture of auditing in order to establish a frame of reference on which future acquisition of knowledge can be grounded | Chapter 1.3.2.1 Challenges posed by the way the qualification process for chartered accountants in South Africa is currently structured  
Chapter 3.3.2.1 Simulations – Accounting education |
<p>| 5   | Would not place additional strains on the lecturers, who already have a full course to teach | Chapter 2.3.4.1 Interactive learning – Potential benefits |</p>
<table>
<thead>
<tr>
<th>NO.</th>
<th>OVERALL GOALS OF THE EDUCATIONAL COMPUTER GAME</th>
<th>PARAGRAPHS IN THIS STUDY THAT GIVE RISE TO THE OVERALL GOAL</th>
</tr>
</thead>
</table>
| 6   | Would not add too much to the already substantial load of the current programme (e.g. not be too time-consuming) | Chapter 2.3.1.2 Annual projects – Challenges  
Chapter 2.3.2.2 Case studies – Challenges  
Chapter 2.3.3.2 Problem-based learning – Challenges  
Chapter 2.3.6.2 Role play – Challenges  
Chapter 2.3.10.1 Information technology integration – Potential benefits  
Chapter 2.3.10.2 Information technology integration – Challenges  
Chapter 3.3.1.2 Case studies – Auditing education  
Chapter 3.4 Considerations for the design of an experiential teaching aid  
Chapter 3.5 Motivation for the design of an educational computer game |
| 7   | Aim to supply a bridge for the gap between the classroom and the real world, so that students will learn to apply a theoretical knowledge framework when they are confronted with a real-world business situation | Chapter 1.3.4 Inherent reasons why students struggle with Auditing as a theoretical subject  
Chapter 1.3.5 Criticism of traditional auditing education |
<table>
<thead>
<tr>
<th>NO.</th>
<th>OVERALL GOALS OF THE EDUCATIONAL COMPUTER GAME</th>
<th>PARAGRAPHS IN THIS STUDY THAT GIVE RISE TO THE OVERALL GOAL</th>
</tr>
</thead>
</table>
| 8   | Aim to develop some judgement and critical thinking abilities that will equip them to face the daily challenges of auditing practice | Chapter 2.2  Experiential teaching methodology  
Chapter 2.3.3.1  Problem-based learning – Potential benefits  
Chapter 3.3.3.2  Educational games – Auditing education  
Chapter 3.4  Considerations for the design of an experiential teaching aid  
Chapter 4.2.1.3  Writing good problems |
| 9   | Foster a general understanding of the concepts of auditing, which will subsequently enable students to comprehend the rules better and to remember them longer | Chapter 1.3.2.1  Challenges posed by the way the qualification process for chartered accountants in South Africa is currently structured  
Chapter 1.3.5  Criticism of traditional auditing education  
Chapter 2.2  Experiential teaching methodology  
Chapter 3.3.2.1  Simulations – Accounting education  
Chapter 3.4  Considerations for the design of an experiential teaching aid |
Next, the specific design considerations to take into account when designing the game had to be established. These formed the foundation for establishing the specific objectives of the game.

4.4 ADDRESSING SPECIFIC DESIGN CONSIDERATIONS

In order to ensure that the goals of the educational game were achieved, it had to be ensured that the game was designed in such a way that achievement of these objectives was possible. In order to ensure that all necessary considerations specific to the successful design of the game was taken into account, a literature review was performed to identify advice and findings of previous researchers who also battled with the question of how to design an experiential method in such a way that it achieves its educational goals. The findings of this review is summarised in the table below and has been interpreted (in the right column) in order to specifically be of value in this study. It is indicated how these factors were taken into account in the design of the educational game.
### CONSIDERATION

In order to facilitate game-based learning (which is in essence PBL), the game needs to be based on a problem that is both educational and viable to incorporate in gaming (Section 4.1).

Assessment is a crucial learning factor in determining the success of any experiential method (Friedlan, 1995; Milne & McConnel, 2001).

According to Wilkinson (1992), a good lecturer ensures that content is understood before moving on.

According to Wilkinson (1992), a good lecturer helps students recognise the relevance of the content.

According to Wilkinson (1992), a good lecturer aims to help students retain knowledge.

### WAY IN WHICH IT WAS ADDRESSED

The case problem was invented with reference to previous case problems used in auditing education. It was written with pre-set learning outcomes in mind.

A marking plan (memorandum) was written along with the case problem with allocated marks for each section. The assessment function was integrated into the game through a gradebook function.

The game was programmed into stages. Each stage required a minimum demonstration of skills before the player can move on to the next stage and eventually complete the game.

The problem and storyboard focused on some of the main areas of application of the auditing process and aimed to demonstrate where these fit into the cycle.

The game was programmed in such a way that the player will not be able to progress in the game before achieving a minimum score (by giving a minimum of set answers). In this way, the player will be forced to understand the content of the one stage before progressing to the next, which should have a positive effect on the players’ ability to retain knowledge.
When there is a time constraint placed on the experience, the problem should only focus on the most important facts (Fouché, 2006).

The case problem was written to take into account some of the most important steps in the auditing process. In this way, the students could gain an understanding of how the process interlinks, but were not too heavily saddled with more work for which they did not have time.

The playing tempo of the game needs to be regulated. Players need sufficient time to reflect on the consequences of their actions (Kiili, 2007).

The game included non-interactive story segments and tutorials, which interspersed the gameplay, and gave the students time to reflect on the consequences of their actions as well as to link the theory to the actions in the game world.

A number of game designers recommend using instructional support and guidance within student-centred instructional approaches such as experiential learning in order to facilitate learning (Kebritchi & Hirumi, 2008; Leemkuil et al., 2003).

Instructional support such as hints, tools, tips and mini-tutorials was included in the user interfaces of the game.

Sandford and Williamson (2004) suggest that the process of achieving goals, even if it is exciting and engaging, should still be logical and consistent and have a firm rationale.

The storyboard of the game was chronologically ordered in order to tell the story of an audit engagement from beginning to end. All objectives were given in this context.

Students need feedback in order to determine how successful they are progressing in terms of completing a certain goal or assignment.

The game provided valuable feedback to students in the form of meaningful scores, replays and skill measurements.
The promise of educational games is to engage and motivate players through direct experiences with the game world, and this promise should be adhered to (Kiili, 2005a).

<table>
<thead>
<tr>
<th>The game world was modelled on the real public practice auditing world by making use of illustrative animations.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessments were integrated into the prototype game as a gradebook function.</td>
</tr>
<tr>
<td>The educational objectives of the problem were properly planned before the problem was written. The user interfaces and functions of the game were properly planned before the programming commenced. The testing of the game was properly planned and executed within a controlled group environment.</td>
</tr>
</tbody>
</table>

Assessment of case problems, though fairly straightforward, can be very time-consuming (Libby, 1991).

In order to ensure that students perceive any experiential educational event as a positive and worthwhile experience, proper planning of the event is essential (Kamoun & Selim, 2007).
CONCLUSION

This chapter examined the design notes that were used for the development of the educational game to be used in undergraduate auditing education. It became apparent in this study that the design process is twofold, as consideration has to be given to all educational as well as gameplay aspects in order for the development to be successful and for the computer game to achieve its goals to both educate and engage undergraduate auditing students.

It was decided that the game would be grounded in the pedagogy of guided experiential learning theory, which means that the students experienced real-life situations in a simulated environment. Learning occurred through stages of reflection on experiences and immediate feedback after a completed task. To this end, the game included an animated game world and storytelling to facilitate the active experiential stages of the game. Gameplay was regulated to allow time for reflection and assessment was integrated into the game as a gradebook function. This may lessen the burden on the lecturer and provide more immediate feedback to the students. Extra guidance was included in the game in the form of tutorials, hints, tips, mini-tutorials and other integrated educational material.

The goals of the educational game were summarised in this chapter, as well as the specific design considerations to ensure that the game is designed in such a way that its goals can be achieved.

This chapter addressed Specific objective 5: Through review of research done on the use of experiential teaching methods, identify best practice and restrictions to be taken into account when developing the prototype game (see Section 1.5.2 in Chapter 1).

The next chapter describes the application of the above identified design considerations in the development of the educational game to be used in undergraduate auditing education.