2 Review of literature on learning and games

This chapter provides a review of the research literature in relation to games and learning in Higher Education, which underpins and informs the work discussed in this thesis. This review is broken down into three sections: first, there is a discussion of theories of learning that are pertinent to teaching in Higher Education; second, there is an examination of literature relating to game-playing; and finally, these are drawn together in an exploration of work relating to learning with games.

The inception of educational gaming dates back to the 1950s with the integration of war-gaming, computer science and operations research, coupled with the progressive educational theories that emphasise active, experiential learning and reflection. The first computer games were developed in the late 1960s and it was not long before computer games were also being used and developed for educational purposes (Wolfe & Crookall, 1998). Educational games and gaming simulations have been used for many years in the fields of business, training staff in fiscal and economic skills, and in the military for combat training and war-gaming. The health sector has been using gaming visualisation techniques for several years, for example through the use of virtual patients, and aircraft pilots often use aircraft simulations in the early stages of training (Kirriemuir, 2002).

There are many examples of different and innovative ways in which computer gaming has been used to support learning and teaching in recent years, both with children and in Higher Education. For example, recent research with school children includes the use of bespoke science games (Magnussen, 2005), off-the-shelf historical games (Squire & Barab, 2004), and multi-user gaming environments (Barab et al, 2005). Examples of recent research in Higher Education include the use of games to support the learning and practice of civil engineering concepts (Ebner & Holzinger, 2006), a competitive game to teach programming (Lawrence, 2004), and virtual reality games used with geography students (Virvou & Katsionis, 2006).

Some studies use existing commercial games in a teaching context, for example using the Civilization game to teach history to school students (Squire, 2005), while others involve the creation of a bespoke game, such as the action–adventure game developed to teach basic literacy skills to adults (Kambouri et al, 2006) or a collaborative mathematics game developed for children (Klawe, 1999).

While there is some experimental evidence that computer games increase motivation (e.g. Squire & Barab, 2004; Ebner & Holzinger, 2006) and can be an effective way to enhance learning (e.g. Klawe, 1999; Kambouri et al, 2006; Hämäläinen et al, 2006), much of the research into game-based learning is anecdotal and small-scale (e.g. Becker, 2001) or does not address issues of educational effectiveness (e.g. Dziabenko et al, 2003). There is an identified need among policy makers for more robust empirical work to provide a baseline of evidence on how educational games can be used most effectively to teach (de Freitas, 2007). Mitchell and Savill-Smith (2005) conclude that:

> the literature base is relatively sparse, findings often conflict in their outcomes, there is a lack of studies regarding educational games use by adolescents, some studies have methodological problems, and longitudinal studies are needed. (Mitchell & Savill-Smith, p 61.)

Wolf (2001) suggests that the lack of academic research into games in general could be due to their status as ‘games’, something seen as more trivial and frivolous, which separates them from traditional media such as books or film, and that they are more difficult to study than traditional media because they are harder to master and because of the time they take to experience.

This chapter considers a range of theoretical literature on learning and gaming, as well as discussing a number of recent empirical studies, their limitations and the evidence they present. First, learning theories as they relate to Higher Education are considered to provide a pedagogic foundation for further consideration of computer game-based learning.

2.1 Learning in Higher Education

This section introduces and examines theories of learning that support the use of game-based learning in Higher Education and that have influenced the research presented in this thesis. The starting point is a discussion of the constructivist perspective on learning and teaching, which is followed by a discussion of collaborative learning, experiential learning, problem-based learning and adult learning.

2.1.1 Constructivism

The way in which learning is perceived has changed significantly over the last century. Until the late 1950s the behaviourist school of thought was predominant, which saw the mind as a ‘black box’ that could be studied by examining observable changes in behaviour, where learning could be reinforced and the consequences of our actions would affect subsequent behaviour. In the late 1950s, cognitivism became the dominant instructional paradigm, where the focus is on thought processes behind behaviour, looking particularly at the main areas of cognition, sensory receptors, executive control, working memory and long-term memory. More recently, the constructivist paradigm has become the prevailing way in which the theory of learning is described (Cooper, 1993).

Bruner (1966), one of the first theorists to be considered by others to work within the constructivist scope, proposed the idea that learning is active and that learners construct their own knowledge about a subject through active engagement in learning by building on past knowledge and experiences. He theorised that instruction should engender a predisposition to learn, specify the ways in which to structure knowledge so that learning is most effective and specify the most effective sequences in which to present the materials to be learned. In its totality, the constructivist view consists of a number of theories and perspectives; however, Savery and Duffy (1995) provide a summary of three fundamental precepts:

- Situated cognition – individuals’ understandings are developed by interactions with their environment; they are formed by a combination of content, context, activity and goal and are individually constructed; they

cannot be shared, but compatibility of understandings can be tested through discussion with others.

- Cognitive puzzlement – cognitive conflict or puzzlement is the stimulus for learning and determines the organisation and nature of what is learned; there is always a goal for learning something and this goal is a primary factor in determining what the learner attends to and what is constructed.
- Social collaboration – knowledge evolves through social negotiation and through the evolution of the viability of individual understandings; the social environment is critical to the development of understanding, and other individuals are a primary mechanism for testing understandings and providing sources of alternative views to challenge thinking.

The constructivist perspective hypothesises that people learn by constructing their own perspectives about the world, by problem-solving and personal discovery. The design of student-centred online learning environments and interactive, exploratory learning objects has been very much influenced by the constructivist perspective (e.g. Grabinger et al, 1997; Land & Hannafin, 2000).

Wilson (1996) defines a constructivist learning environment as:

> a place where learners may work together and support each other as they use a variety of tools and information resources in their guided pursuit of learning goals and problem-solving activities. (Wilson, p 5.)

Honebein (1996) presents a number of pedagogic goals of the design of constructivist learning environments. He says that they should support students to take responsibility for their learning, including the topics they pursue, methods of learning and strategies for problem-solving; provide experience of multiple perspectives and viewpoints; encourage ownership and self-awareness of the learning process; make learning realistic and relevant, based on authentic, real-life activities; make learning a social experience, supported by collaboration and interaction; use multiple modes of representation; and use rich media.

These concepts of constructivism and constructivist learning environments are of particular relevance to this study because of the way in which these principles are reflected in certain types of computer game. For example, games can provide the opportunity for learners to explore and navigate immersive virtual worlds using rich media, they can create authentic contexts for practising skills that can be transferred to the real world, and they can present a forum and context for problem-solving. Collaboration and learning from others is fundamental to the constructivist perspective, and multi-user games or collaborative game playing in the same physical space are two ways that facilitate this.

The issues of support for student responsibility for planning and structuring learning, and meta-cognition and engagement in the learning process are not ones that are normally considered within games, even those designed for education. It is therefore important to consider the context in which games for learning are used, their role in the curriculum and the activities that precede and follow any game for learning. Prensky (2001) makes the argument that if games were used for learning then “learning would happen almost without the learners’ realizing it, in pursuit of beating the game” (p 26). Without debriefing and reflection, to support the learner to understand the process, context and transferability of learning, the value of learning undertaken in this way is questionable.

In the following sub-sections, four areas of learning theory are discussed, which are related to the use of constructivist learning environments in Higher Education. These are collaborative learning, experiential learning, problem-based learning and adult learning. Each of these areas supports the rationale for the use of games as constructivist learning environments by showing how games can exhibit characteristics of effective learning environments.

2.1.2 Collaborative learning

Central to the notion of constructivist learning is the idea of students working together, sharing and clarifying ideas and opinions, developing communication skills and learning from one another. Working collaboratively enables students to work to their strengths, develop critical thinking skills and creativity, validate

their ideas, and appreciate a range of individual learning styles, skills, preferences and perspectives (McConnell, 2000; Palloff & Pratt, 2003; Palloff & Pratt, 2005).

Vygotsky's (1978) work in the field of social constructivism is particularly concerned with the collaborative aspects of learning, theorising that learning takes place at a social level first and then at an individual level. His theory of Zones of Proximal Development contends that the zone of proximal development is the difference between what a student can learn working alone, and what he or she can achieve when being supported and guided by a teacher or some other expert.

Participating in communities of practice provides a legitimate and ongoing way of learning from others as part of a group through apprenticeship and education in the context of the group norms, processes and identity (Lave & Wenger, 1991). Wenger (2000) describes these communities of practice as "the basic building blocks of a social learning system" (Wenger, p 229).

One of the significant advantages in the growth and ubiquity of personal networked computers is the potential to develop virtual communities of learners. Collaborative online learning communities involve the "bringing together of students via personal computers linked to the Internet, with a focus on them working as a 'learning community', sharing resources, knowledge, experience and responsibility through reciprocal collaborative learning" (McConnell, 2006, p 11).

Multi-user gaming communities provide a similar platform for collaboration and the ability to learn with others. Studies of leisure users of Massively Multi-user Online Role-Playing Games (MMORGs) have found evidence of collaborative learning, development of communities of practice (Steinkuehler, 2004) as well as the potential for learning a range of group skills, including the etiquette of meeting people, group management, co-operation and social interaction (Ducheneaut & Moore, 2005).

2.1.3 Experiential learning

The constructivist perspective also puts forward the idea that students learn better by exploring and experiencing authentic contexts for themselves and discovering their own meaning from the experience. The Experiential Learning Cycle (Kolb, 1984) is shown in Figure 2-1 below. This model emphasises the importance of active learning, with planning, reflecting and theoretical underpinning. According to this cycle, learning takes place as part of a sequence of steps. The student starts by actively undertaking the learning experience (stage 1), which provides a concrete experience; this is followed by personal reflection on the experience (stage 2). The reflection is followed by the application of known theories to the experience, or the derivation of rules from it (stage 3, abstract conceptualisation) and finally the learning is used to inform, modify and plan the next learning activity (stage 4, active experimentation).

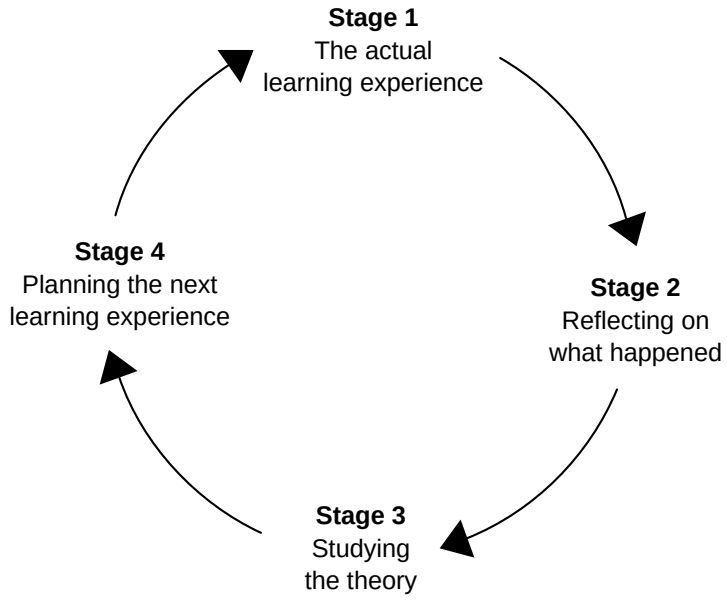

Figure 2-1: The Experiential Learning Cycle (Kolb, 1984)

One of the primary benefits of computer-based learning, which also applies to game-based learning, is the ability of the computer to provide the interaction and feedback that is crucial to the experiential learning cycle. Sims (1997) says that “interaction is intrinsic to successful, effective instructional practice as well as individual discovery.” (p 158). Computers can facilitate a whole range of types of interaction from basic items that can be clicked, moving backwards or

forwards through a linear sequence, to the use of hyperlinked environments and virtual interactive worlds (Sims, 1997).

Gee (2003) argues that computer games reflect the experiential learning cycle in that students must examine the virtual environment, reflect on the situation and form a hypothesis about what something in the situation might mean, and re-probe the virtual world to see what effect it has. While it is true that this cycle maps onto learning within the game world, it does not necessarily provide students with scope for the meta-cognitive processes that are required for them to truly engage with and take responsibility for their own learning when applying their learned knowledge and skills to the real world. It is important to recognise that game-based learning is necessarily part of a larger learning process and should be considered in terms of the other activities and reflection that surround the game and not as a stand-alone activity.

2.1.4 Problem-based learning

Problem-based learning as a teaching and learning method is considered here because of the clear parallels between a problem-based approach and the activities that take place in certain types of computer game, such as puzzle or adventure games.

Problem-based learning generally involves small groups of students working with a facilitator to tackle real-life, cross-disciplinary problems. Resources are made available to the students but information on how to tackle the problem is not provided, and work is carried out intensively on one problem at a time. This provides activity-based learning, with students taking more responsibility for their own learning and learning in a real-world context (Boud & Feletti, 1991). The Internet can also be used to facilitate problem-based learning. Jonassen (2002) describes a number of different types of problem that can be addressed in this context, including logic problems, application of algorithms or rules, diagnostic or troubleshooting problems, strategic problems, design problems and dilemmas.

Researchers have highlighted that computer games have the facility to create real-life problem-solving experiences. Kiili (2005) argues 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 causally linked problems." (Kiili, p 17), and in a survey of 25 educational 'experts' using game-based learning, de Freitas (2006) found that "broadly the experts interviewed seemed to advocate the use of simulations and games for problem-based learning." (de Freitas, 2006).

However, it is important to note that problem-based learning is essentially a collaborative method of learning, and to exploit the full potential of this teaching philosophy in a gaming situation, collaborative or multi-player games would be better suited to provide this than games played individually.

2.1.5 Adult learning

The research described in this thesis is concerned with the implementation of games in Higher Education, rather than examining the use of games with school-based learners. Therefore, an understanding of how learners in Higher Education may differ in their approaches to learning is important in the design of any learning experience, games included.

Although 18-year-old first year undergraduates may have more in common with school-based learners, there is a growing representation of mature and adult learners in Higher Education. Adult learners are typically defined as individuals "who have returned to learning after some kind of separation from a formal educational environment such as school, college or university" (Hodson et al, 2001, p 327) and who may typically have more work and personal responsibilities, caring commitments, greater life experiences and a need for greater study guidance.

Adult learning theory, or andragogy (Knowles, 1998), argues that the key characteristics of adult learners, as related to their motivations and learning needs, are that:

1. Adults need to know why they need to know something before they are willing to invest time and energy in learning it.
2. Adults have a deep psychological need to be self-directing and to take responsibility for their own learning.

3. Adults have a wide variety of backgrounds and experience and it can not be assumed that all adult learners come from the same starting point.
4. Adults become ready to learn something when they need to know it to be able to cope effectively with real-life situations.
5. Adults are task-oriented in their learning. They learn things best in the context of using them to do things they want to do.

It is important to note, however, that pressure of life and work commitments and limited time to devote to study is becoming more true of younger students also. Adult learning theory has much in common with the constructivist approach in that it advocates learners taking responsibility for their learning, and learning through experience in an authentic context, so it can be argued it is actually of relevance to all learners to varying degrees.

Rogers (1989) also describes a number of practical factors that contribute to effective learning in adults, again highlighting the importance of the learning being relevant to real life and also the need to enable adult learners to control the pace of their work, breaking down learning into manageable chunks, basing learning on previous experience and making use of the wealth of previous experiences, and creating an awareness of the meta-cognitive processes associated with learning.

Adult learning theory highlights the fact that motivation to learn is paramount and that learning activities must be purposeful. This brings into question the acceptability of game-based learning with adult learners, who may perceive games as frivolous and a waste of time (empirical evidence to support this is discussed in Chapter 4).

In all, the theories discussed in this section – constructivism, collaborative learning, experiential learning, problem-based learning, and adult learning – are closely related in terms of pedagogic stance; that is, empowering learners to take control of developing their own learning, questioning in real-life situations and learning from others. The next section considers the characteristics of games that might form a definition of game-based learning, presents a framework of genres of game from which to consider which are most applicable

to game-based learning in Higher Education, and considers theories relating to gaming and engagement.

2.2 Games

Having considered a number of educational theories that support the potential value of game-based learning, this section examines some of the theoretical constructs associated with the nature of games and gaming in order to provide a basis for considering different game types for their potential educational value. In particular, the characteristics of a game are discussed and a working definition postulated, a taxonomy of game genres is presented as a starting point for considering the types of games that may be appropriate for certain types of learning, and the nature of engagement with games is considered.

Play is a powerful influence on learning that is fundamental to the development of both adults and children (Rieber, 1996), promoting engagement and mastery of developmental tasks (Colarusso, 1993). Koster (2005) says that games are a fundamental part of the evolving human experience and the way in which we learn, providing the opportunity to practise and explore in a safe environment, teaching skills like aiming, timing, hunting, strategy and manipulation of power.

However, there are misconceptions associated with play that might affect the acceptability of game-based learning, particularly for adults in Higher Education. Play is perceived by many as only for young children, as not being a respectable thing to do, and as activity that is easy (Rieber, 1996). There is a potential dichotomy relating to educational games: play is seen as being a source of joy and fun and essentially voluntary (Caillois, 1961), yet when it is used as part of formal education the voluntary aspect may be removed.

This highlights a strong need for game-based learning to be purposeful, and to be perceived as such by the learners, so that games are not perceived as frivolous and learners are willing to undertake them voluntarily (as, in essence, all participation in Higher Education is voluntary) as the most effective way to learn. This is supported by the background research discussed in Chapter 4.

In order to identify the boundaries of this study, the next sub-section of this chapter attempts to clarify exactly what is meant by a game in the context of game-based learning.

2.2.1 Defining a game

The first question considered as part of this research into games and learning was exactly what is meant by the term ‘game’. Wittgenstein (1958) argued that it is not possible to come up with a single definition of a game but different types of games are, in fact, related by a number of ‘family resemblances’, and that an exact definition of a game is not essential to use the term effectively. However, in order to provide a frame of reference for this research, analyse differences between different types of games, and establish what activities are included in the definition of game-based learning, some consideration of this issue is important. This section provides a summary of the characteristics that have been used to define games by researchers and practitioners, and from this, describes a framework for analysing game-based learning activities.

There are many definitions in the gaming literature regarding what makes an activity a game and what the defining characteristics of a game are. A selection of definitions are considered here, first examining three definitions from researchers into non-computer-based educational games, then three from designers of games for entertainment, then finally three from researchers in the field of computer game-based learning.

Definitions from the field of non-computer game-based learning include that of Ellington and colleagues (1982), who define a game as necessarily containing rules and overt competition, either between other players or against the game system. This limitation to overt competition appears to be somewhat restrictive, however, particularly when considering co-operative learning games, and Klabbers (1999) uses a wider definition including competition or challenge and describes games as “an activity or sport involving skill, knowledge or chance, in which you follow fixed rules and try to win against an opponent to solve a puzzle.” (Klabbers, 1999, p 18). Greenblat (1987) defines games as simulations that work wholly or partly on the basis of players’ decisions, which have roles, goals, activities, constraints and consequences.

Definitions from commercial game designers have a different perspective. Crawford (1984) argues that the elements that define a game are representation (a closed formal system with explicit rules that represents a subjective, fantastic, subset of reality), interaction (social or personal), conflict or challenge, and provision of a safe environment, i.e. one where consequences do not hold in reality. Oxland (2004) says that games need rules and boundaries, feedback, an interface to the game world, context sensitivity (or immersion), goals, quests and challenges, a game environment and balance (or playability). Koster (2005) provides a much less formal definition, saying that games are puzzles to solve, they are exercises for our brains and that it is the act of solving these puzzles that makes games fun.

It is hardly surprising that there is more focus on playability and fun in the definitions created by game designers in the entertainment industry, and it is important not to lose these elements of what makes games engaging when considering how games could be used for learning. This is not an easy task, as Virvou and colleagues (2004) highlight, saying that “educational software games aim at serving two distinct aims, which are often conflicting each other: education and entertainment” (p 692).

More recent definitions by researchers in the field of computer game-based learning have more in common with those of non-computer-based games researchers. Dempsey and colleagues (2002) define a game as an activity involving players (one or more), with goals, constraints, payoffs and consequences, which is rule-guided, artificial in some respects and has an element of competition, while Prensky (2001) describes six structural elements of games; namely rules, goals, outcomes and feedback, competition or challenge, interaction, and representation or story. A wider definition is used by de Freitas (2006) who defines computer-based learning games as:

> applications using the characteristics of video and computer games to create engaging and immersive learning experiences for delivering specified learning goals, outcomes and experiences. (de Freitas, p 9.)

From consideration of these definitions, it was felt to be unhelpful and artificial – if not impossible – to create a distinct and absolute division between what is and

is not a game in a computer-based environment. There is no common definition in the literature and practitioners from different disciplines have varying perspectives. However, it was felt to be useful to highlight characteristics of games that commonly occur in the definitions presented and to use these to create a framework for examining different types of game and support an inclusive definition of ‘game’, with activities being more or less ‘game-like’. The more of these characteristics an activity possesses, the more essentially ‘game-like’ it can be considered to be. These ten characteristics of game-based activities are defined in Table 2-1.

Characteristic	**Definition**
Competition	Where the goal is to achieve better than other people.
Difficulty	Presentation of tasks that require effort.
Exploration	A context-sensitive virtual environment.
Fantasy	A make-believe environment or story.
Goals	Explicit aims and objectives, with a clear purpose.
Interaction	Feedback from actions and changing state of play.
Outcomes	Measured results from game play (e.g. scoring).
People	Other individuals playing the game at the same time.
Rules	Boundaries of play, limitations or constraints.
Safety	Lack of consequences of the game in the real world.

Table 2-1: Ten characteristics of game-based activities

The characteristics of ‘fun’ and ‘playability‘ are not included here as characteristics of games because, while they might be something for which game designers strive, they can not be objectively observed as characteristics of games but are dependent on the perception of the individual playing the game.

These ten characteristics are closely aligned to what individuals perceive a game to be (see Table 4-1 in Chapter 4) and are used to consider which activities can be considered as game-based learning throughout this thesis. The more of these characteristics an activity exhibits, the more game-like it is considered to be (for example, the Time Capsule and Pharaoh’s Tomb activities are considered in relation to this framework in Table 9-1 in Chapter 9).

There are several types of activity that are associated with games and are often included in discussions of game-based learning. These include simulations, microworlds, role plays, puzzles, toys, and stories. There is disagreement among researchers over whether these activities constitute games or not, but the inclusive definition described above enables any of these activities to be considered under the heading of ‘game-based learning’, albeit some with more gaming characteristics than others.

Two domains closely associated with games are simulations and microworlds. There are many similarities between simulations and games, and the term ‘simulation-game’ is often used to describe an object that has characteristics of both. Simulations attempt to model an environment with as much realism as possible, and show genuine cause and effect, and while they can be explored and experimented in, they do not have to have defined goals. Simulations are often used when there is some reason why the actual system cannot be experienced, such as cost, danger, inaccessibility or time (Rieber, 1996). A microworld is an artificial environment, which can be described as “a small, but complete, version of some domain of interest” (Rieber, 1996, p 46). While microworlds are similar to simulations and can be confused with them, they differ in that they first present the learner with the simplest case of the domain (Rieber, 1996).

Another area often associated with games is role play. Role-playing allows people to take part in an experience by acting out the role of a character in a particular situation and experiencing empathy with that character. Role plays often follow a set of rules and involve interaction with others, but do not always have defined goals (Feinstein et al, 2002). While it is possible to have a role play that is a game (role-playing games themselves being a prime example), role plays can have many other uses such as experiential learning, empathy, or relaxation.

Puzzles are another activity that are often likened to games and, in fact, many games have elements of puzzle-solving. Crawford (1984) argues that it is interaction that makes an activity a game rather than a puzzle, in that puzzles do not actively respond to the human’s moves. However, he also says that “we

can easily turn many puzzles and athletic challenges into games and vice versa. For example, Chess, a game, has spawned a whole class of puzzles, the end-game problems." (Crawford, 1984, online).

The essential difference between toys and games is that toys do not have goals and set rules of play whereas games usually do. With a toy, the designer has almost no say over the players' final experiences (Crawford, 1984). Stories are another form that share some of their characteristics with games, particularly the element of fantasy. The distinction between games and stories is that stories are essentially linear and non-interactive while games are non-linear and interactive. Rockler (1989) argues that mystery stories are themselves games to some extent, particularly detective fiction, in that they have a set of rules (e.g. readers must be given access to all the clues, the suspects must be known and the murderer among them) and an outcome.

Koster (2005) argues that toys, games, play and sport are the same at the most fundamental level. He says that:

> Playing a goal-oriented game involves simply recognizing a particular sort of pattern; playing make-believe is recognizing another one. Both deservedly belong in the same category of "iconified representations of human experience that we can practice with and learn patterns from" (Koster, p 36).

Adopting an inclusive definition of computer game-based learning enables all of the activities described above to be considered part of the spectrum as they all share characteristics with computer games. This inclusive definition enables this research to focus on an examination of how different game characteristics affect learning rather than a semantic distinction between games and non-games. In the next sub-section the characteristics of different genres of computer game are considered.

2.2.2 Genres of computer game

As well as examining the characteristics of games, this research considers which particular types of games might be more appropriate to teaching particular skills to learners in Higher Education. In order to provide a framework in which to do this, an analysis of genres of computer game was undertaken.

Many researchers have tried to categorise computer games into types or taxonomies, and although there are small differences between them, there is also much similarity in terms of the general categorisation. Oxland (2004) makes the point that:

> Identifying what constitutes a genre has been fraught with ambiguity, mainly due to the creative flux our industry introduced, the overlap of genres and the constant churn of technology and ideas (Oxland, p 24).

Wolf (2001) describes over 40 different genres of game but it was not felt to be helpful here to deal with so many distinctions. The purpose of investigating genre was to determine a manageable number of discrete classifications of game with distinct characteristics, that could be readily understood by participants in research and used to map educational design characteristics onto genres in order to decide on a particular type of game to develop (see Chapter 6).

Genre	**Definition**	**Examples**
Adventure	A game involving a series of quests or puzzles, where the protagonist must move through a virtual world performing actions and manipulating objects to achieve the game's aim.	Myst The Hobbit
Platform	A game in which the primary aim is negotiating movement between a series of platforms, avoiding obstacles and enemies and picking up treasure.	Sonic the Hedgehog Super Mario Brothers
Puzzle	A game that primarily involves logic and puzzle-solving.	Lemmings Tetris
Role-play	A game in which the player takes on a fantasy role and takes part in adventures within a fantasy world.	Dragon Quest Neverwinter Nights
Shooter	Played in the first person, a game that involves exploration of virtual worlds, weapons and combat.	Doom Quake
Simulation	A game that models some sort of virtual environment and allows interaction with that environment.	Sim City The Sims
Sports	A game in which the player undertakes a virtual sporting activity.	FIFA Football Alpine skiing
Strategy	A game in which strategic decisions must be made to meet the overall goal.	Chess Dungeon Keeper

Table 2-2: Eight genres of game with definitions and examples

For the purposes of this research, a list of game genres and definitions (see Table 2-2 above) was extracted from the literature (Prensky, 2001; Wolf, 2001; McFarlane et al, 2002; Makar & Winiarczyk, 2004; Oxland, 2004). This list was felt to be representative of the literature, providing distinct classifications, while not including so many sub-classifications as to be unmanageable. Even so, it is worth noting that a game may still fall into more than one category. This taxonomy is used as a basis for considering the types of game that might be most suitable for use in education (see Section 6.2).

2.2.3 Games and engagement

One of the key features of games is their ability to engender engagement, and engagement is also an important factor that contributes to effective learning, so the nature of engagement with games is essential for consideration.

Benyon and colleagues (2005) say that:

> engagement is concerned with all the qualities of an experience that really pull people in – whether this is a sense of immersion that one feels when reading a good book, or a challenge one feels when playing a good game, or the fascinating unfolding of a radio drama (Benyon et al, p 61).

They identify a number of key elements that contribute to engagement in virtual environments: a sense of authenticity and identification, adaptivity of the environment, compelling narrative, immersion and flow (Benyon et al, 2005, based on Shedroff, 2001).

Jones (1998) defines engagement in the context of online learning as “the nexus of intrinsic knowledge and or interest and external stimuli that promote the initial interest in, and continued use of a computer-based learning environment” (Jones, online).

As a way of examining the concept of engagement in more detail, Flow theory (Csikszentmihalyi, 1992) is particularly useful. Csikszentmihalyi’s research is based primarily on empirical data, asking people spontaneously about what they were doing and how they were feeling, with a large number of subjects over long periods of time. Flow theory describes the state of optimal experience,

which is supposed to bring happiness, and is described as “the state in which people are so involved in an activity that nothing else seems to matter; the experience itself is so enjoyable that people will do it even at great cost, for the sheer sake of doing it” (Csikszentmihalyi, p 4). Being in a state of ‘flow’ is considered here to be very close to being highly engaged.

Flow theory states that the following elements add to enjoyment, and the more of these elements that are present, the more enjoyable, engaging and immersive an activity is:

- a challenge that requires skills with an attainable goal and known rules;
- complete absorption in the activity;
- clear goals;
- immediate feedback;
- concentration on the task in hand;
- a sense of control, lacking the sense of worry about losing control;
- loss of self-consciousness;
- transformation of time.

Flow theory is not without its opponents. Draper (1999) criticises the theory, saying that flow is not a single concept but is actually broken down into u-flow and c-flow. U-flow is a smooth but unconsciously managed flow of actions (e.g. driving a car) whereas c-flow requires the total attention and consciousness of the individual (e.g. playing a game of chess). He also argues that engagement only occurs where there is a “connection to the person’s deepest values and goals” (Draper, 1999, online). Salen and Zimmerman (2004) make the point that flow is intrinsic to the game but is dependent on the state of mind of the player. This is an important issue to consider in the context of the research presented here: the characteristics of a gaming activity are viewed as objectively observable (see Table 2-1) while engagement is viewed as a subjective state observable only to the individual taking part in the activity (a breakdown of characteristics of engagement used for this study can be found in Table 8-1).

Malone (1980a, 1980b) produced some of the original and seminal work in gaming and engagement. He investigated the elements that make computer games engaging and how those features that make games captivating might be used to make game-based learning more interesting and enjoyable. His work was undertaken with children and while he does make the assumption that computer games are intrinsically motivating he also admits that "…it is clear that there are big differences between people in the kinds of games they [children] like. No single instructional game can be expected to appeal to everyone" (Malone, 1980a, p 21).

Malone initially presented three aspects of games that lead to increased engagement: challenge, fantasy, and curiosity. Appropriate challenge can be created by the use of goals, which should be obvious, compelling and adaptable, coupled with an uncertainty of whether these goals can be met. He argues that short-term goals are more motivating than long-term and that fixed goals (e.g. winning a game) are more motivating than emergent goals (e.g. painting a picture). Creating the optimal level of challenge for an individual is seen as key; according to Malone, "an environment is not challenging if either the person is certain to reach the goal or certain not to reach the goal" (Malone, 1980a, p 52).

Fantasy can be intrinsic, where the skill or knowledge to be learned is closely related to the fantasy, or extrinsic, where the skill does not depend on the fantasy. Malone states that intrinsic fantasies are generally more interesting and instructional, and that instructional fantasies serve wish-fulfilment and conflict-resolution functions. Curiosity can be sensory (light, sound, other sensory stimuli) or cognitive, which involves the prospect of modifying high-level cognitive structures, ensuring that understandings are complete and consistent. Feedback should be surprising and constructive. Malone and Lepper (1987) extend Malone's original theory to include the additional factor of control, which is broken down into contingency (where interactions are logical), choice (a large number of options are available) and power (a decision has a powerful effect).

It is worth making a couple of points regarding the value of this work as related to learning in Higher Education today. First, Malone's work was conducted with

children, and although his findings may be replicable with adults, there is no evidence of this, and while some of the factors intuitively make sense when applied to adult motivation (e.g. goals, control) other factors are less compelling (e.g. fantasy). Secondly, Malone's work took place during the 1980s, a period when computer games were new to most children and were to some extent motivating purely for their novelty value; today, games are ubiquitous and people are far more sophisticated in their expectations of games. Even so, Malone's work is still regularly used as a basis for work on game design and engagement (for example, recent references include Sandford & Williamson, 2005; Dickie et al, 2006; Ebner & Holzinger, 2006) and has been endorsed and applied by many other researchers since its inception, so it is viewed here overall as still being valid but to be applied with some caution.

The final section of this chapter examines the research literature on computer game-based learning, focusing in particular on the advantages and potential disadvantages of using games in education.

2.3 Computer game-based learning

In recent years, there has been a growing interest in computer game-based learning. A number of factors have brought this about, including the move from traditional, didactic teaching theories to more learner-centred, active models of learning, coupled with the availability of easy-to-use games creation technologies and the growing body of evidence that games can be an effective tool for learning, as well as motivating and engaging students (Garris et al, 2002).

This section first discusses reasons highlighted in the literature on computer game-based learning for its effectiveness, and then provides some examples of empirical studies showing the use of game-based learning. Finally, this section examines some of the weaknesses and problems associated with the use of computer game-based learning.

2.3.1 Rationale for computer game-based learning

Throughout the literature on game-based learning, in the case of both adults and children, an assumption is commonly made that the rationale for using

games for learning is that games are intrinsically motivating (e.g. Nawrocki & Winner, 1983; Driskell & Dwyer, 1984; Sweeters, 1994; Grice & Strianese, 2000; Alessi & Trollip, 2001; Becker, 2001; McFarlane et al, 2002; Oblinger, 2004).

These assumed motivational factors surrounding games are often used as a rationale for using games for learning, the argument being that if the motivational factors associated with games could be transferred to learning then the learning would be more effective. Dempsey and colleagues (2002) make this assumption and provide examples of suggested uses of existing computer games in educational settings, but do not provide any evidence that motivation to play games for entertainment necessarily leads to motivation to use games for learning.

Reflecting on this assumption, particularly with adult learners in Higher Education, it is evident that not all people are intrinsically motivated to play games, nor indeed are people who are motivated to play games for leisure necessarily motivated to play them to learn (see Chapter 4). However, this assumption is still rife in the literature.

There are several possible explanations for this widely held and little-questioned assumption regarding the motivational aspects of games. Games researchers tend to be highly motivated to play games themselves, and do not consider those individuals for whom game playing is not motivating, or indeed is actually demotivating. It is also self-selecting games enthusiasts who often participate in gaming studies, which only serves to propagate the assumption. In addition, much of the research literature in this area is based around studies carried out with children, a population who are more likely to be motivated to play with games, from which the results are generalised to adults.

Despite the potential motivational aspects of games not providing a compelling rationale for their use educationally, there are other pedagogic reasons for considering computer game-based learning. A more persuasive argument for using games to learn is based around the changing profile of modern learners.

Prensky (2001) describes the definite distinction between ‘Games Generation’ learners, or ‘digital natives’ who have grown up with computer games, television, and other media, and use them to learn instinctively; and older learners, for whom interacting with these types of technology has to be done through conscious effort and who exhibit more traditional learning strategies. He argues that the generation of people brought up in a world of computers are cognitively different from previous generations and that this immersion in technology has fundamentally changed the way in which people acquire and assimilate information. He describes ten cognitive changes in people of the Games Generation.

- Games Generation learners are used to processing information at a much faster pace than traditional learners.
- Games Generation learners can process information from several sources at once.
- Games Generation learners will focus on graphics and images before reading the textual information.
- Games Generation learners will not follow a linear path through learning materials, but will take a more random, hypertextual route.
- Games Generation learners will expect to work with others rather than alone; collaboration and teamwork will be the norm.
- Games Generation learners take a much more active role in seeking out information and deciding what to learn.
- Games Generation learners have a much less distinct boundary between what is considered play and what is work. Playing games to learn will not be anathema to them.
- Games Generation learners expect quick rewards and quick feedback and will soon become demotivated if they do not experience quick gains for effort.
- Games Generation learners are more accepting of fantasy concepts than traditional learners.
- Games Generation learners are comfortable with and enthusiastic about new technologies and quickly embrace change and advancement.

While many of these ideas regarding changes in learners may seem instinctively correct, it should be noted that these characteristics are based on experience rather than on empirical studies. It is also important to note that the increasing numbers of mature students in Higher Education means that many learners are simply not part of Prensky’s ‘games generation’.

Gee (2003) puts forward the argument that video games can be used to learn because they have good learning principles built into them. He argues that playing video games involves learning a new literacy and although games are not necessarily appropriate for teaching content, they do teach people how to interact in a new domain and learn transferable skills. He says that when we learn new domains we learn to experience things in new ways, gain the potential to join new social groups and prepare for future learning in related domains.

Other hypothesised educational benefits of learning with computer games cited in the literature include improvement in practical reasoning skills, motivational levels and retention (Rieber et al, 1998) and the ability of games to push learners forward, adjust to the skill levels of the players, and support alternative learning styles (Jenkins, 2002). Computer games are suited to learning because they enable players to practise the skill of learning and are designed so that players take control of their own learning (Papert, 1998).

There are also a number of researchers who believe that students can learn by developing or creating games, as well as simply playing them. Reiber (1998) argues that learning by building games can be an at least, if not more, effective way to learn than traditional methods, while Shubik says that “possibly at least as important as playing a game is constructing one” (Shubik, 1989, p 186). Gee (2003) argues that active, critical learning should lead to learners becoming designers, either by physically designing extensions to the game or by cognitively extending the game design and using that to inform their play.

The next sub-section examines a number of case studies of game-based learning and discusses the empirical evidence of the learning effectiveness of the games used.

2.3.2 Evidence of learning with games

There is an identified need for a greater number of rigorous studies investigating the use of game-based learning (Mitchell & Savill-Smith, 2005; de Freitas, 2007). In this sub-section, a number of studies that have taken place in recent years are presented and discussed. It examines some of the empirical

evidence that is available as to the educational value of game-based learning. The studies selected here aim to provide a representative sample of the type of research that is being carried out in the area and the issues that commonly arise.

The studies described here also provide an overview of the data collection and analysis methods that are commonly used in the area, and highlight some of the methodological issues. Examples are used from (non-computer) game-based learning, and computer game-based learning in schools, Higher Education and continuing education.

Evidence of learning through non-computer games goes back many more years than does that with computer games. Randel and colleagues (1992) present a meta-analysis of 67 existing studies on educational gaming and simulations from 1963 to 1991, all of which involved school-age children; of these studies, they report 27 to show a significant difference in favour of games (although they say that five of these used questionable controls). Sun (1998) describes research undertaken using a role-playing game to teach the basic principles of operations management. A basic evaluation was carried out with fourth-year and Masters-level students who had used the game, through group discussion at the end of the playing session. The paper describes the evaluations as very positive, saying that the students found the game interesting, they felt involved, they perceived it to be helpful to understanding theory and appreciated the ability to apply theory to practice. Despite the positive evaluation outcomes, the evaluation itself appears to be somewhat ad hoc and lacks rigour; this is typical of much of the research on the use of games that is reported.

More recently, O'Leary and colleagues (2005) undertook a study to compare learning satisfaction and effectiveness between game-based learning and traditional lectures for third-year medical students. They used a pre- and post-test to evaluate learning and a satisfaction survey. The study showed no difference in learning between the two groups but the group using the game rated it higher for satisfaction.

Studies have also been undertaken with school students of a range of ages to examine the effects of game-based learning. Sung and colleagues (2006) undertook an experiment with 59 children aged four and five years to compare the relative effectiveness of two software applications increasing the children's understanding of taxonomy, including classification and identifying characteristics. Three experimental groups were used: one using a game, one alternative software, and a control group with no intervention. A pre- and post-test was used to determine learning. The study showed evidence that the game supported learning of some taxonomic concepts compared to the other software and control group.

Magnussen (2005) describes a study that was undertaken to evaluate the learning potential of a cross-disciplinary science game that simulated a forensic investigation used in schools. This was a small-scale study that used data based on observations from play tests with two classes of children. The analysis showed evidence of learning from the game, in particular collaborative learning, the ability to handle large amounts of data, and the establishment and testing of theories.

In an example of the use of commercial computer games in education, Squire and Barab (2004) used the commercial strategy game Civilisation III to teach history to 18 students in High School. The evaluation was based around a case study design with pre- and post-tests; however, the students simply refused to complete pre-tests so no data on learning are available. In addition, observations, journals, and interviews were used to gather data. This study provides evidence of engagement with the game once students were aware of the purpose of the game and could see the potential for learning through re-enactment of history.

Fewer examples of studies of this type are available from Higher Education than from the school sector. Hämäläinen and colleagues (2006) describe an evaluation of a 3-dimensional virtual game environment for promoting collaboration in students in Higher Education. Twenty-four students played the game, in six groups (each with four players), and a range of data gathering techniques were used including video observation, questionnaires, interview,

screen capture and personal notes. The study found that the game was effective for supporting a range of team skills, and the teams exhibited collaborative behaviours including joint goal orientation, effective negotiation, co-ordination of different perspectives and information sharing.

Also in Higher Education, but in the field of civil engineering, Ebner and Holzinger (2006) evaluated a game for teaching theoretical concepts to Masters-level students. This study uses a pre-test/post-test method to compare learning between a group of students who attended lectures and played the game voluntarily and those who just attended lectures. There was no significant difference in learning between the two groups. However, there are issues of bias with this methodology due to the voluntary nature of participation.

Computer game-based learning studies have also been undertaken in the area of adult and continuing education. Gander (2000) evaluated the use of a computer-based adventure training game for teaching information systems concepts to adult learners. Thirty students took part in the evaluation and were split into three groups, each playing for different lengths of time (30–90 minutes) and undertaking a pre- and post-test as a way a measuring learning. The results of the tests show that learning was certainly happening in the groups that used the games for 60 minutes or more, but since the experiment did not use a control group, it is impossible to determine whether this would be the most effective way to teach this subject.

Kambouri and colleagues (2006) describe the use of a game developed to motivate young adult learners to improve their basic literacy skills and provide a forum in which they could practise the skills developed. This relatively small-scale study involved 13 learners, who undertook pre- and post-session interviews, and completed questionnaires. The results showed that the game had engaged the students and helped them to make significant literacy gains beyond those expected by the educators and game designers.

In all the areas of education discussed here, there is limited empirical evidence to show that game-based learning is any more effective than traditional methods, although there is more evidence that students enjoy games more.

There are a range of practical issues associated with the use of games in learning, particularly formal learning, which might have impact on their educational effectiveness; these limitations are discussed in the following sub-section.

2.3.3 Weaknesses of game-based learning

A major practical issue in the use of computer games for learning is how to design and develop the educational game to be used; whether to use off-the-shelf games software designed for entertainment, or to create bespoke educational games.

The problems associated with the design of bespoke education software often involve the amount of money spent on producing it compared to entertainment software, and how this affects the expectations of learners. Jenkins (2002) argues that most educational software is of poor quality, badly edited and unprofessional. It will never be the case, however, that the amounts of money spent on commercial software will be available for education, and it is more important that resources be used to ensure that educational games are well designed in terms of playability and learning. The growing trend towards modifying existing games software for use in education (de Freitas, 2007) may provide one way to address this issue.

Other criticisms of game-based learning include that transfer of game-based learning to real life may not be clear (e.g. Dempsey et al, 1993–94), that motivation to play a game may actually be detrimental to learning (e.g. Jacques et al, 1995) and that games may be a less efficient manner of learning than traditional methods, not least because of the amount of time that is required to become proficient at the game, time that could be used for learning (e.g. Alessi & Trollip, 2001).

Some of the other disadvantages associated with computer game-based learning include that it is often difficult to pitch games at the right level of interest and challenge for their intended users, they can be gender-specific and often have violent or stereotypical characters, and most educational computer games

are designed as single player whereas collaboration and group work can dramatically enhance learning (Becta, 2001b).

In addition, there is evidence that using game-based learning may discriminate against girls and may lead to aggressive, addictive or anti-social behaviours (Sandford & Williamson, 2005), that they may be impractical to run in a classroom setting because of time constraints and the time taken for teaching staff to learn and support games (Becta, 2001a), there may be a lack of available equipment (de Freitas, 2007) and there are issues with ensuring alignment between games outcomes, learning outcomes and assessment (Sandford et al, 2006). Jones (1997a) argues that, while games and simulations can be powerful learning tools, they can also damage personal relationships and cause emotional hurt and distress.

A number of practical constraints also exist concerning the use of games in teaching, including increased preparation time for academics and teachers (who may be less familiar with the technology than the students), the difficulty of ensuring that the learning outcomes of the game are appropriate for the learning outcomes of the curriculum, a range of technical and administrative issues, inappropriate resources, and a fear of the unknown on the part of teaching staff (Lean et al, 2006).

Despite the disadvantages and practical implementation issues, it is clear that certain types of computer game do have the power to engage certain types of people. If games can be designed to encapsulate the learning principles discussed in Section 2.1 of interactive and collaborative experimentation as well as learning content that is appropriate to the curriculum and assessment, then they can clearly be an appropriate tool for learning. Whether they are the most appropriate and acceptable to learners will depend upon the particular learning context in which they are used.

As de Freitas (2007) says, “the key challenge for effective learning with games is for the learner to be engaged, motivated, supported and interested but also importantly for the learning to be undertaken in relation to clear learning

outcomes as well as being made relevant to real-world contexts of practice." (p 5).

In all, this chapter has provided an overview of and drawn together the research literature in the fields of learning in Higher Education, games, and game-based learning, looking at a number of learning theories and linking them to characteristics of games to support a rationale for games-based learning in Higher Education. This chapter has shown the theoretical potential for computer games to be an effective way to teach, as long as they are underpinned by effective pedagogy.

This link between games and learning is revisited in Chapter 6, where the potential of different game genres to embody the educational principles described in this chapter is discussed.

The following chapter moves on to describe and consider the research design for the work described in this thesis, including the research philosophy, techniques employed and ethical considerations.