Chapter II
Learning and Teaching with Computer Games in Higher Education

Nicola Whitton
Manchester Metropolitan University, UK

ABSTRACT

This chapter examines the rationale for the use of computer games in learning, teaching, and assessment in Higher Education. It considers their pedagogic potential in respect to a number of theories of learning, as well as some of the practical issues associated with using computer games in real teaching situations, both face-to-face and online. The first part of the chapter focuses on the theory underpinning the use of computer game-based learning with HE students, examining motivation and engagement, constructivism, collaborative and problem-based learning. The second part of this chapter considers the practical issues of using computer games in actual teaching contexts and presents twelve principles for the design and evaluation of computer games to support learning.

INTRODUCTION

In recent years there has been increased awareness of the potential of computer games in education, including growing interest in their application in Higher Education. An increasingly diverse student population, with different backgrounds and abilities, has contributed to a rethink about effective ways of teaching and learning, and games-based learning offers many pedagogic benefits over traditional methods of teaching and learning.

Play is a powerful learning tool, which is essential to the development of both adults and children (Rieber, 1996), promoting engagement in learning and mastery of tasks (Colarusso, 1993). Games are a fundamental part of the human experience and the way in which learning takes place, providing the opportunity to practise and
explore in a safe environment, and providing a forum for learning basic human skills like aiming, timing, hunting, strategy and manipulation of power (Koster, 2005).

There are many examples of innovative ways in which computer gaming has been used to enhance learning and teaching, both with children and adults. Research with school children includes the use of science games (Magnussen, 2005), historical games designed for entertainment (Squire & Barab, 2004), and multi-user gaming environments (Barab et al, 2005). Research in Higher Education includes the use of computer games to support the learning and practice of civil engineering concepts (Ebner & Holzinger, 2007), competitive games to teach programming (Lawrence, 2004), and virtual reality games to teach geography students (Virvou & Katsionis, 2006).

This chapter examines the rationale for the use of computer games in learning, teaching and assessment, with a particular focus on adult learners in Higher Education. It considers their pedagogic potential in respect to theories of learning, and discusses some of the practical issues associated with using computer games in real teaching situations. This chapter is based upon the author’s doctoral research into the use of collaborative game-based learning in Higher Education (Whitton, 2007).

The initial section of this chapter examines the pedagogic benefits of computer games for learning, exploring first issues of motivation and secondly examining the potential of games in relation to different theoretical perspectives. The next section of the chapter examines practical issues associated with using computer game-based learning in Higher Education, presenting a number of principles for effective educational game design and discussing implementation issues such as the framing of the games within a learning package, and the assessment of computer game-based learning. Finally, the chapter closes with some concluding remarks on the advantages and disadvantages of computer game-based learning.

COMPUTER GAMES FOR LEARNING

One reason often put forward for using computer games in education is their motivational benefits. This section will argue, however, that the motivational aspects of games are often over-stated and secondary to the pedagogic benefits inherent in the design of certain types of computer game. First, issues associated with the motivational aspects of games are discussed, drawing on a small-scale study into motivations for adults playing games, and secondly, a number of theories of teaching and learning are explored in relation to their applicability to computer game-based learning.

Motivational Aspects of Computer Game-Based Learning

A reason commonly put forward for using game-based learning is that it brings benefits in terms of student motivation for learning. While this may be a more realistic assumption for children, this supposition is less compelling when applied to adult learners. Adult motivation to learn with games is explored here, and evidence presented that the motivational aspects of games should not be a primary reason for their use in Higher Education.

There is an assumption often made in the literature on game-based learning that the majority of people – if not all – find games intrinsically motivating (e.g. Alessi & Trollip, 2001; Prensky, 2001; McFarlane et al, 2002; Oblinger, 2004), and that this is a good reason for using them to teach. In order to investigate how true this assumption is for adult learners, and to explore motivations for using games, a small scale study was undertaken in 2004 to explore these issues. This study also aimed to provide evidence as to whether computer game-based learning would be perceived as an acceptable, if not intrinsically motivational, way to learn by students in Higher Education.
The first part of this study was based upon the phenomenographic methodology, and consisted of a twelve interviews with current and ex-students, to examine their motivations for playing games and their attitudes towards game-based learning in education. The interviews were followed up by the use of a survey questionnaire with 200 undergraduate and postgraduate students, with the intention of examining how representative the opinions expressed in the interviews were in a student population.

The method for data collection and analysis of the initial set of interviews drew on phenomenography, a research approach designed to answer questions about how different people view different aspects of reality. It aims to investigate how people perceive the world and categorise the different conceptions they have about the object of interest (in this case, computer games for learning), and does not try to represent reality, but how reality is perceived by individuals (Marton, 1981). The primary outcomes of phenomenographic research are categorisations of description, which look at the ways in which people perceive the phenomenon. The primary method of data collection is open-ended interviews, which allow discussion of many possible areas and let the interviewees talk about the subject from their own points of reference.

Student perceptions of game playing for learning was considered to be an appropriate topic for the use of phenomenography, but the work described here is not phenomenography in the purest sense because of the small number of participants. However it did embrace the techniques and philosophy of the method, and, as part of a mixed-methods study, it was felt that a relatively small number of participants would be sufficient to draw out themes and opinions without making the amount of interviews unmanageable (the interviews are backed up with a quantitative survey with a larger population).

There were an equal number of male and female participants, half of whom considered themselves to be ‘game players’ and half saw themselves as ‘non-game players’ (i.e. people who play games by choice as a matter of course and those who do not). Each interview lasted between 30 and 90 minutes and was based around core questions but kept as unstructured and open as possible, so the actual questions and lines of discussion varied as different themes and topics were brought up by the different participants. The interview transcripts were analysed iteratively, initially examining them to draw out themes and hypothetical categories of description, then re-analysing to test statements in the interviews against the proposed framework, until a set of categories were arrived at that accounted for the perceptions of all individuals interviewed.

The analysis showed, perhaps unsurprisingly, that the participants who considered themselves to be game players had different motivations for playing games than those who did not. Those who considered themselves to be game players appeared to have one of three primary motivations, although these motivations are not mutually exclusive. The motivations for game players were: playing for intellectual challenge, playing for social interaction, and playing for physical exertion. For those people who did not consider themselves to be game players, there were generally only two circumstances in which they would play games: killing time, and social facilitation, for example an icebreaker game as a way of getting to know people. However, it is worth noting that although there were clear indications of primary motivations with this small sample, these findings would need to be tested against a far larger population before there could be considered valid.

Overall, the feelings of the participants towards game-based learning were positive, even from those individuals who did not consider themselves to be game players. All of those interviewed said that they would be open to the idea of using a game to learn – if it was seen as being the most effective way. Interestingly, only two people out of those interviewed said that using a game to
learn would be intrinsically motivating. Clearly this is a small-scale study on a small group, so the results may be entirely due to chance, but are indicative of the fact that while games may not be motivating for adult learners in themselves, they may still be an acceptable method of learning.

To complement these interviews, a larger scale quantitative survey was carried out to discover how valid these results are in the context of a larger population. The group used for this study were third-year undergraduate, and Masters-level postgraduate, computing students. This group were selected for two reasons: first, the pragmatic reason that this was a student group that could easily accessed by the researcher; and second, it was hypothesised that computing students would be among those most likely to be motivated to engage with game-based learning. Therefore if it could not be shown that game-based learning was seen as an acceptable or motivational way to learn by this group, there would be little justification for using increased motivation as a rationale for using computer games for teaching in other areas of Higher Education.

A short questionnaire was designed to elicit gaming preferences, motivations and attitudes towards the use of games in education. This questionnaire was pre-tested with a small number of individuals to ensure question clarity and un-ambiguity, and finally revised before being used for this study. Four classes of students (n=200), all of whom were taking a Group Project unit, were asked to complete the questionnaire at the end of a lecture. The majority of those who completed the questionnaire were males aged between the ages of 20 and 29, which is representative of the total population of the programme, and is a group that might be considered to be most likely to engage with games for entertainment (Entertainment Software Association, 2007).

From the survey data, the two predominant motivations for playing computer games were to be able to interact with others and for the mental challenge. This provides some evidence that motivations for playing games in this group are aligned with the types of games that may be most appropriate for learning in Higher Education (i.e. those that are collaborative and are mentally challenging). It is important to note that it cannot be assumed that even when students are motivated to play computer games, that they will be motivated to play the same types of games that would be appropriate for learning in a specific context, and that there is no guarantee that the games that the students chose to play in their leisure time are those that they might be most motivated to use for learning.

The survey respondents were asked to consider if they would be positively motivated to learn something using a game, whether they would not be motivated either way, or whether they would actually find a game demotivating. Less than two-thirds (63%) of the respondents said that they would find educational games positively motivational, with 28% saying that they would not be influenced either way and 9% responding that they would find games for learning demotivational. While the majority of students said that they would be motivated to learn with games, it is interesting that this number is not higher in a group of predominantly male, largely young, computing students, who might be expected to be particularly motivated to learn with computer games. Further analysis of the data from this questionnaire also found no evidence that people who are motivated to play games in their leisure time will be motivated to play games for learning.

It is clear – and hardly surprising – that the use of computer games for learning is not intrinsically motivational for all students, but the interviews conducted provide some evidence that they can still be seen as an acceptable and appropriate way to learn in Higher Education, if they are perceived by the learner as being an effective way to learn, and not simply used for any perceived motivational benefits.

In terms of the rationale for using computer games, the fact that games are thought to be
motivational is not in itself a sufficient rationale for using a game. This is not to say that computer games should be excluded from Higher Education, only that the sole reason for using them should not be their perceived motivational benefits – the rationale for using games to teach must be that they embody sound educational principles. If a game is perceived as being the most effective way to learn in a particular context, then students will be more likely to be motivated to use it to learn, not simply because it is a game. The ways in which educational principles and theories of teaching can be embodied in games are explored in the following section.

Computer Games and Theories of Learning and Teaching

In this section a number of different theories of learning and teaching will be explored in relation to the potential of computer games as learning environments, again with a particular focus on Higher Education and adult learners. This section highlights the idea of computer games as constructivist learning environments.

One of the key features of computer games is their ability to engender engagement, which is an important factor that contributes to effective learning. Benyon and colleagues (2005) describe engagement as being “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).

There are a number of elements that contribute to engagement in virtual environments, including a sense of authenticity and identification with the characters and virtual gaming world, the adaptivity of the environment, a compelling narrative, immersion and flow (Benyon et al, 2005, based on Shedroff, 2001). Flow is 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, 1992, p 4).

Computer games have the potential to be highly engaging learning environments because they can create compelling narratives within immersive and challenging worlds, with high levels of interaction and feedback.

The way in which the process of learning is viewed by academics has changed significantly over the last century. Until the late 1950s the behaviourist school of thought was predominant, and the mind was seen as a ‘black box’ that could be studied by observing changes in behaviour, where learning could be reinforced by punishments or rewards. In the late 1950s, cognitivism became the dominant way of thinking about how people learn, where the focus is on the mental processes behind behaviour, particularly focusing on cognition, sensory experience, and memory. More recently, the constructivist paradigm has become the prevailing way in which the theory of learning in Higher Education is described (Cooper, 1993).

Bruner (1966) proposed the idea that learning is an active process and that people construct their own insights about a subject by building on past knowledge and experience. He theorised that teaching should stimulate an inclination to learn, specify ways in which to structure knowledge so that learning is most effective, and identify the most effective sequences in which to present the materials to be learned. Many later theories in the constructivist paradigm stem from this work, and in its totality, the constructivist view consists of many theories and perspectives. Savery and Duffy (1995) provide a summary of three fundamental precepts of constructivism: the notion of situated cognition where individuals’ understandings are developed by interactions with their environment in an authentic context; cognitive puzzlement that provides the stimulus for learning; and social collaboration where knowledge evolves.
through discussion with others and is a primary mechanism for testing understandings and providing sources of alternative views to challenge the ways in which people think. Certain types of computer games, such as multi-user adventures, simulations and role-playing games, with their rich interactive context, increasingly difficult challenges, and forum for social interaction and collaboration, provide powerful constructivist learning environments.

The constructivist viewpoint hypothesises that people learn by building their own perspectives about the world, by problem-solving and personal discovery. The design of student-centred online learning environments has been greatly influenced by this 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” (p 5). Constructivist learning environments should allow students to take responsibility for their own learning, including what and how they learn; provide exposure to multiple views; encourage awareness of the learning process; make learning relevant, based on real-life activities; make learning a social, collaborative and interactive; and use multiple modes of representation and rich media (Honebein, 1996).

Computer games can provide the opportunity for learners to explore and navigate immersive virtual worlds using rich media, create authentic contexts for practising skills that can be transferred to the real world, and present a forum and context for problem-solving. Collaboration and discussion with others is central to the constructivist perspective and multi-user games or group game playing in the same physical space are two ways that facilitate this. However, issues of support for student responsibility for planning and structuring learning, and meta-cognition of the learning process are not ones that are usually considered within computer games, even those designed for education. It is therefore important to take an holistic view of the learning context in which computer games are used, their role in the curriculum, and the activities that precede and follow any game for learning to support reflection, consolidation and application of learning.

Providing a collaborative forum for computer gaming, be that in-game or in the real world, is essential to exploit the full potential of constructivist learning environments, as 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, 2005). Multi-user gaming communities can provide a platform for collaboration and learning with others. Studies of Massively Multi-user Online Role-Playing Games have found evidence of collaborative learning and development of communities of practice (Steinkuehler, 2004) as well as the potential for learning a range of group skills (Ducheneaut & Moore, 2005).

Vygotsky’s (1978) work in the field of social constructivism is particularly concerned with collaboration, and he theorised that learning takes place at a social level first and then at an individual level. The theory of Zones of Proximal Development (Vygotsky, 1978) contends that the zone of proximal development is the difference between what an individual can learn working alone, and what he or she can achieve when being supported and guided by an expert. Participating in communities of practice provides a legitimate way of learning from others through apprenticeship and education in the context of the group norms, processes and identity (Lave & Wenger, 1991). 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).

The constructivist perspective also supports the idea that learning is best facilitated by allowing students to explore and experience authentic contexts for themselves and to ascertain their own meanings from their experiences. The Experiential Learning Cycle (Kolb, 1984) describes an iterative process of learning in four stages, and emphasises the importance of active learning, with a need for planning, reflection and underpinning by theory. According to this cycle, the student starts by being involved in a learning experience (stage 1); this is followed by personal reflection on the experience (stage 2). The reflection is followed by the application of known theories to the experience (stage 3) and finally the learning is used to inform, modify and plan the next learning activity (stage 4). One of the advantages of computer game-based learning is the ability of the computer to provide the personalised interaction and feedback that is crucial to the experiential learning cycle. Gee (2003) argues that computer games reflect the experiential learning cycle in that students must iteratively examine the virtual gaming world, reflect on the problem presented and form a hypothesis about how the situation might be resolved, take action in the virtual world and see what effect the action has had. While this cycle maps onto learning within the game world, it does not intrinsically provide learners with space for learning about and reflecting on learning, which is an essential part of the learning process, particularly for adults (Knowles, 1998). It is important to recognise that computer game-based learning is necessarily part of a larger learning process and should be considered as integral to the other activities and self-reflection that surround the game and not simply as a stand-alone activity.

Researchers have also highlighted that computer games have the facility to create real-life problem-solving experiences similar to the model of problem-based learning, which involves small groups of students working with a facilitator to tackle real-life, cross-disciplinary problems where resources are made available to the students but information on how to tackle the problem is not provided. Kiili (2005) suggests 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). 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.

This review of theories of learning and teaching, as they relate to Higher Education, has highlighted some of the similarities between the constructivist perspective and certain types of computer game, in particular simulations, role-play and adventure games. There is a clear pedagogic rationale for the use of games that can provide a situated and authentic environment in which students can work collaboratively to undertake meaningful tasks, solve purposeful problems, and receive appropriate feedback.

LEARNING WITH COMPUTER GAMES IN PRACTICE

The third section of this chapter examines the practical issues that arise when using computer games in actual teaching contexts in Higher Education. First, a second study is presented from which a set of principles of effective pedagogic design for computer games were produced, and secondly a range of practical issues are discussed,
such as the fit of the game to the curriculum, the match between learning and gaming outcomes and methods of assessing computer game-based learning.

**Principles for Design**

When it comes to designing, developing and evaluating computer game-based learning applications for use in teaching adults, it is crucial to recognise what constitutes good design in terms of educational effectiveness, as well as good game and interaction design. This sub-section describes a research study that was undertaken to create a set of guidelines that can be used to support the creation and evaluation of educational computer games for use in Higher Education. The study comprised two phases, a review of existing guidelines in related areas and an analysis of popular internet games. These two pieces of work were drawn together to produce two sets of guidelines for the design of effective web-based educational games, one focusing on the learning design the other on the usability of the interface.

In the first phase of the study, existing design guidelines in three areas related to effective educational online game design were reviewed and synthesised. The areas examined were (a) the design of constructivist learning environments, (b) the design and use of educational multimedia, and (c) the design of engaging computer-based activities and games.

Alessi and Trollip (2001) present fourteen principles that, in their view, support the production of knowledge from a constructivist view, while Savery and Duffy (1995) present eight principles of teaching that derive from constructivism. Hannafin and Land (1997) put forward eleven assumptions about student learning from a constructivist perspective and provide examples of how these can applied in learning environments. Jonassen (1999) presents a framework for designing constructivist learning environments.

A number of design guidelines for the production of effective multimedia were also examined. Cates (1992) provides fifteen principles for designing more effective multimedia products, while Park and Hannafin (1993) provide twenty. Stemler (1997), Najjar (1998), and Lee and Boling (1999) all describe ways in which a user interface and multimedia elements used can support learning with multimedia. Mayer (2001) brings together his work with that of others in designing effective educational multimedia and presents seven principles that are pertinent to its design and, by extension, the design of educational games that use multiple media.

As well as examining guidelines for the design of constructivist learning environments and educational multimedia, guidelines on the design of engaging computer games were also considered. Jones (1997) suggests a number of features of games that lead to increased engagement: production value, being fit for purpose but not gratuitous; providing a mix of thinking skills and motor skills, immediate feedback coupled with strategy for a greater feeling of accomplishment; research and problem-solving; a safe place to learn from mistakes; and immersion through characters and circumstances that can be related to, and controls that make sense. While many of these factors make intuitive sense in an educational as well as an entertainment context, particularly as regards research and problem-solving, and the provision of an authentic and meaningful context, it is more difficult to argue that the use of games that test motor skills is appropriate for much of the learning that takes place in Higher Education.

Malone (1980) produced a seminal work in designing engaging educational games, and although his work was carried out in the context of children’s learning it is still of some relevance here as background. Malone investigated the elements that make computer games engaging and identified features that make games captivating, immersive and enjoyable. The initial analysis
presented three aspects of games that lead to increased engagement: appropriate challenge, a compelling fantasy, and creating curiosity in the environment. Malone and Lepper (1987) extend Malone's original theory to include the additional factor of control, consisting of a large number of options available, logical and consistent control over the environment, and a feeling of power in the game. While Malone's work is useful for gaining a greater understanding of why games can be so engaging, there are a couple of points worth making regarding the value of this work in relation to learning in Higher Education today. First, Malone's research was carried out with children, and although his findings may be replicatable in adults, there is no evidence of this. Some of the factors intuitively make sense when applied to adult engagement (e.g. challenge, curiosity, control) but other factors are perhaps less compelling in an adult context (e.g. fantasy). Secondly, Malone's work took place during the 1970s, a period when computer games were still a novelty, whereas today, games are ubiquitous and people are far more sophisticated in their expectations. Even so, Malone’s work is still used regularly as a basis for work on game design and engagement (for example, recent references include Sandford & Williamson, 2005; Dickie et al, 2006; Ebner & Holzinger, 2007) and has been endorsed and applied by numerous other researchers since its inception.

Lepper and Malone (1987) suggest a number of general principles for increasing the engagement with, and therefore effectiveness of, learning. Since their work was carried out with children and is not wholly applicable to adults only the aspects that are considered to be appropriate to adult learning were included in the analysis. Lepper (1998) also highlights a number of design principles for promoting intrinsic motivation for instruction and engagement with learning, while in a more recent study by Becta (2001), several factors are highlighted for increasing and sustaining engagement (again, this last study is in the context of children and has been applied, where appropriate, to adult learning).

As well as examining guidelines and literature on effective educational design, in order to achieve a better first-hand understanding of the types of popular computer games available and gain insights into the educational potential of different gaming types, an evaluation was carried out of the characteristics of popular web-based computer games. This review aimed to provide an overview of the types of game that were popular and analyse the design and interface characteristics of these games that could potentially contribute to engagement.

Popular commercially-produced computer games are expensive, can be time-consuming to install, and often require several hours of play to simply work through the tutorial, so this study focused on freely-available web-based games because they are generally easy to access, quick to learn, and there are a large number available with a wide variation of genre, interface, design and goals. Since this review aimed to examine some of the most popular free web-based games available at the time (2004), the Channel 4 Games web site (see http://www.channel4.com/games) was used as a starting point. This site provides links to many hundreds of games of various genres, which are rated and ranked by the site users.

Over one hundred web-based games were initially examined and sixteen were selected for further evaluation, based on six criteria. Games selected had to be available for free on the web, robust, with no obvious errors and continuously available over a period of time, of a type considered appropriate for educational use (in general, the games selected focused on adventure, role-play, simulations and puzzles), and not designed exclusively for children.

In addition, for a game to be selected for inclusion in this review it had to manifest one or more original or unique characteristics that were considered to be worthy of note in terms of educational value or interface design. Each game was played...
by the researcher for a minimum of 20 minutes, after which an analysis was made of the game in terms of areas of educational potential, elements of the game or interface design that contributed (positively or negatively) to player engagement, and ideas from the interface that were seen to be useful or innovative and could be implemented in the game-based applications developed as part of this research.

The review of guidelines in the literature was combined with the games analysis to produce two sets of criteria for effective educational computer game design for adults, the first focusing on the pedagogic design and the second on aspects of the interface design. The first set of guidelines highlights six criteria that can be used to evaluate the educational design of a computer game-based learning application for adult learners. These areas are: the ability of the game to support active learning, the degree to which it is designed to stimulate engagement, the appropriateness of the game for the desired learning outcomes, the degree to which it supports the reflective process, the extent to which it provides an equitable experience for all learners, and the availability of ongoing support throughout the game. These criteria are expanded in Table 1.

As well as this set of guidelines that can be used to support the educational design of computer games, a second set also came of the literature review and game analysis, which focused on the interface design of game-based learning applications. This second set of six criteria can be used to evaluate where the user interface and interaction models support learning. They are: provision of flexible ways for users to interact with the environment, support for the development of a player community, transparent navigation functions, features that support user control of the environment, robustness of design, and appropriate visual design. These criteria are expanded in Table 2.

In all, these twelve principles provide a set of criteria that can be used to support the design and development of bespoke computer games for learning in Higher Education, as well as the evaluation of existing games. It is worth noting that while these guidelines present ideas for good practice, some of the criteria may impact on each other, be mutually exclusive or be difficult to achieve; the relative importance of each criterion is not considered in this model. Also, as yet, these criteria are relatively untested and further research is required to ensure that they are necessary and sufficient. These criteria should be considered to be an indicator of effective educational design rather than something that must be achieved before a computer game can be considered appropriate for teaching. In practice, there may be many games that are still effective but do not meet all of these criteria. The next sub-section looks at other aspects of the practical implementation of computer games that should be considered.

### Practical Issues of Using Computer Games for Teaching

In this sub-section, a range of practical issues that should be considered when using computer games to support learning and teaching in Higher Education will be highlighted and discussed. The issues include the need for an explicit rationale for using computer games, aligning learning outcomes with gaming outcomes, logistical limitations, the need to build in reflection and collaboration and ways of doing so, and implications of assessing games-based learning.

When using games with adult learners it is essential to have a clear educational purpose, that is explicitly communicated to the students, and that they are not simply used because they are considered to be motivational. While computer games may be intrinsically motivating for some learners, this is often not the case, particularly for older students who are likely to be more strategic in how and what they learn and will often aim to carry out their efficient way to do so (Knowles, 1998). For this type of learner, a game used for its own sake is likely to be an unnecessary dis-
Table 1. Criteria for the effective educational design of game-based learning applications, and elements that support fulfilment of each criterion

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Examples of ways to meet criteria</th>
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<tbody>
<tr>
<td>Supports active learning</td>
<td>Encourage exploration, problem-solving, enquiry. Provide opportunities for collaboration.</td>
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<td></td>
<td>Provide opportunities to test ideas and gain feedback. Provide opportunities for practice and consolidation. Ensure game goals align with learning goals.</td>
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<tr>
<td>Engenders engagement</td>
<td>Give clear and achievable goals. Create a large world to be explored. Support a high level of interactivity. Supply multiple possible ways to complete the game. Stimulate curiosity and puzzlement. Set challenges at an appropriate level, for example by making them gradually more difficult or customisable. Provide sufficient control over the learning environment.</td>
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<tr>
<td>Appropriateness</td>
<td>Ensure game goals align with curriculum, learning outcomes and assessment. Ensure a game-based approach is appropriate for subject matter and acceptable to students. Match game playing time to time available (including set-up, briefing, de-briefing). Make the game personally relevant to students.</td>
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<tr>
<td>Supports reflection</td>
<td>Provide opportunities for structured reflection. Ensure that there is debriefing on learning and consideration of application to the real world. Highlight the process of learning.</td>
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<tr>
<td>Provides equitable experience</td>
<td>Account for differing prior knowledge of the game type. Allow for customisation of the game. Provide equal opportunities to participate.</td>
</tr>
<tr>
<td>Provides ongoing support</td>
<td>Provide an orientation and overview. Allow students to achieve quick initial success with the gradual introduction of complexity. Provide ongoing hints and clues.</td>
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traction. However, while many adult learners may not be interested in learning with a game simply because it is a game, there is evidence, presented earlier in this chapter, that they will be happy to use them if they are perceived as an effective way to learn in a particular context. Some learners will be very happy to use games without questioning their educational value, but this cannot be assumed for all.

A second important issue, and one that is often difficult to counter (particularly if using games originally designed for entertainment) is ensuring alignment between the outcomes of the game and the intended learning outcomes from the game. For example, the intended learning outcome of a multi-user adventure game may be to develop collaborative skills but if the game is designed to be competitive then collaboration is unlikely to happen. If the use of the game does not closely match the learning outcomes and curriculum then the students may be learning something, but it will not be purposeful or relevant in the context of the course of study. Built in to many entertainment games is the goal of learning to play the game itself, exploring the interface and discovering advanced hidden features, which may detract from the desired learning outcomes of the game.

There are also a range of logistical issues to be taken into account in using computer games.
in learning; practicalities such as the amount of time available, both to design and develop the game and associated activities and the time available to use in a teaching setting, limited physical or virtual space available (depending on whether a game is played online, face-to-face or a combination of the two) and the resources available (e.g. access to computers with correct specifications). These practical points need to be considered as they will influence how and when computer games can be integrated into courses or programmes of study.

There are also commonly barriers to use in university settings, with games being seen as inappropriate for learning and banned by some IT departments, or with network ports being automatically locked so that certain communications software or web applications cannot be used. Commercial entertainment games and immersive gaming worlds also often require higher specifications of graphics cards or processors than are typical in university machines. University regulations may also affect how games can be integrated into a course, how they can be assessed, and impact on whether the use of computer game-based learning is a supplemental activity, something that is used once or multiple times, or can be included as an activity that fundamental to the whole structure and design of a course.

There are also technological considerations regarding how to obtain or create a required game. In some instances existing commercial games can be used for learning, for example the game to teach history to school students (Squire,

Table 2. Criteria for the effective interface design of game-based learning applications, and elements that support fulfilment of each criterion

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Examples of ways to meet criteria</th>
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<tbody>
<tr>
<td>Flexible interaction</td>
<td>Make sure that all interaction is purposeful.</td>
</tr>
<tr>
<td></td>
<td>Ensure that feedback is timely and meaningful.</td>
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<td></td>
<td>Controls must be logical and consistent.</td>
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<td></td>
<td>Build in performance indicators.</td>
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<td></td>
<td>Make a range of interaction methods available.</td>
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<td>Support for player community</td>
<td>Provide a facility for players to communicate.</td>
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<td></td>
<td>Provide community self-regulation functionality.</td>
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<td></td>
<td>Use avatars or other individual representations.</td>
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<tr>
<td>Transparent navigation</td>
<td>Make navigation tools clear and consistent.</td>
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<tr>
<td></td>
<td>Provide alternative methods of navigation.</td>
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<td></td>
<td>Ensure that help functionality is obvious.</td>
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<td></td>
<td>Provide an overview of player position in environment.</td>
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<tr>
<td>User control</td>
<td>Make game pace and level adjustable.</td>
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<td></td>
<td>Provide multiple customisation options.</td>
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<td></td>
<td>Enable tasks to be undertaken in any sequence.</td>
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<td></td>
<td>Make instructions obvious and clear.</td>
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<tr>
<td></td>
<td>Ensure that all functionality is appropriate and obvious.</td>
</tr>
<tr>
<td>Robustness</td>
<td>Make it easy to recover from errors.</td>
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<tr>
<td></td>
<td>Ensure the interface is responsive to input.</td>
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<tr>
<td></td>
<td>Provide context-sensitive help and hints.</td>
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<tr>
<td></td>
<td>Provide the functionality to save and return at a later time.</td>
</tr>
<tr>
<td>Appropriate visual design</td>
<td>Make interface simple, uncluttered and aesthetically pleasing.</td>
</tr>
<tr>
<td></td>
<td>Provide information in accessible chunks.</td>
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<td></td>
<td>Ensure consistent of components.</td>
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<tr>
<td></td>
<td>Ensure that graphics and rich media is purposeful.</td>
</tr>
<tr>
<td></td>
<td>Make sure that text legible.</td>
</tr>
</tbody>
</table>
2005), while other examples involve the creation of bespoke applications, such as the action-adventure game developed to teach literacy skills to adults (Kambouri et al., 2006). Using commercial games has the advantage of a high-end product, explicitly designed to be engaging, however they may also be expensive, have complex interfaces and steep learning curves. It can also be difficult to match the outcomes of the curriculum with those of the game so debriefing and reflective activities are particularly important. Many commercial games now come with a creation engine and there is a growing trend towards modifying existing games software for use in education (de Freitas, 2007), which may provide one way to address some of these issues. There are also some commercial games that are specifically designed for learning, but these can be expensive, difficult to customise, and limited numbers of these games exist. An increasingly popular option is the use of massive online worlds for learning, which allow interaction among thousands of players in real-time in virtual spaces, however, many of these worlds lack privacy from other non-student users who can wander into teaching spaces, and because of some of the other activities that take place in what is essential a public space (e.g. sale of pornography, fighting) may be deemed inappropriate for a learning environment. Much more flexibility in design is afforded by the creation of bespoke games, which enable a designed match of learning outcomes with gaming outcomes for a specific user group, but even the best home-grown software is unlikely to compare to big-budget commercial games.

While computer games certainly have the potential to provide active and experiential learning spaces, they do not necessarily offer students space for reflection and application of their newly acquired knowledge and skills to the real world. Activities such as briefing, debriefing and structured reflection are essential to ensure that specified learning outcomes are mastered; these activities can be structured outside the game, and in fact it may be highly beneficial to do so as it creates a safe space outside the virtual world. Support for group interaction is also important but as not all gaming environments are collaborative in nature (and, in fact games that require synchronous communication may not suit autonomous adult learners) it is crucial to build in collaborative facilities and activities to the overall learning package. Ways of achieving this include using face-to-face discussion interspersed with periods of individual (or paired) game play, two (or more) individuals playing the same game at the same time (either face-to-face on the same machine or physically distance on different machines but using an online messaging facility), or using asynchronous message boards to support game play and problem solving.

The way in which computer game-based learning is assessed is another key issue. It is essential to ensure that achievement in the gaming environment has a minimal impact (if any) on the ability of the student to achieve in the assessment, so as not to disadvantage students who might be performing less well in the games for reasons that are nothing to do with their level of learning (for example, students who are unfamiliar with gaming interfaces or have problems navigating in a three-dimensional environment). Well-designed assessments can encourage the development and integration of reflective and collaborative activities, for example, considering how progress through the game could have been different in different circumstances, or working with others to produce a reflective report. Whitton & Hynes (2005) describe the use of a combination of a presentation to a board of directors, strategy report and reflective journal to effectively assess a game-based marketing course.

There are many practical difficulties associated with the use of game-based learning in Higher Education, and they have only been touched upon in this section. However, if implemented thoughtfully and used to exploit their pedagogic potential as constructivist learning environments,
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games have the potential to be an innovative addition to a lecturer’s learning and teaching toolkit, but certainly should not be seen as a panacea to engage a new generation of learners.

CONCLUSION

In all, this chapter has aimed to provide an overview of some of the pedagogic theories that support a rationale for the use of computer games in Higher Education, and to discuss the practicalities of designing effective games for learning and implementing them in real life teaching and learning situations in Higher Education.

When using computer games for learning, as with any innovation in teaching and learning, it is important always to ensure that there is a clear and sound pedagogic justification, which is communicated to the students, and they are not simply being adopted for a perceived motivational effect or because they are seen to be popular. Creating effective educational games is not an easy task and is expensive and time consuming, so it is essential to ensure that the benefits outweigh the challenges.

The novelty effect of using games should also be considered – from both the perspectives of the teacher trying a new teaching method and student taking on a new way of learning. Initial reactions may be influenced by the newness of the methods and may not reflect the long-term acceptability and effectiveness of computer game-based learning.

Despite the disadvantages and practical implementation issues, it is clear that certain types of computer game have the potential to engage people in appropriate and effective learning in Higher Education. If games are designed to embody sound educational principles, and support learning outcomes that are 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 use. 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).

REFERENCES


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