Chapter I
Introduction to Games-Based Learning

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ABSTRACT

Games-based learning takes advantage of gaming technologies to create a fun, motivating, and interactive virtual learning environment that promotes situated experiential learning. Many researchers now believe that this approach can better motivate present day entertainment-driven learners to more thoroughly engage in learning through meaningful activities defined in the game context as opposed to those offered using more traditional didactic approaches. This chapter describes games-based learning, the related terms and scope, current approaches, embedded pedagogies and challenges for providing high-quality education in the 21st Century.

INTRODUCTION

The 21st Century has witnessed emergent cultures such as 'blogging' (Khan & Kellner, 2004), file sharing (Lessig, 2004) and gaming (Pearce, 2006). These digital cultures have significantly changed the ways humans work, communicate, socialise and play and they are also affecting the way younger generations learn. It is crucial that learning is congruent to lifestyle for effec-

tive learning to take place (JISC, 2004). These changes in lifestyle are inevitable and have since introduced additional challenges to teachers in providing high-quality education.

One of the significant changes experienced in the education sector is the change of learners' attitude and their motivation towards learning. Prensky (2005) describes these learners as the 'engage me or enrage me' group that comprises most of the present day learners who believe that education is a waste of time and irrelevant. Such attitudes and motivation towards learning is worrying and is one of the many factors contributing to the decline in applications to science and engineering courses experienced by education establishments worldwide despite the growing requirements for more scientists and engineers worldwide (OECD, 2006; Sjøberg & Schreiner, 2006). Other known challenges include increased diversity of learners and their learning styles, increases in what must be learnt by learners and also the highly constrained resources in education and training (FAS, 2006a).

Many believe that computer games can be used to address the aforementioned issues (FAS, 2006a; Gee, 2003; Prensky, 2001) borrowing success stories from the use of computer games in corporate and military training (Buckley & Anderson, 2006; Jayakanthan, 2002; Nieborg, 2004). The idea of using computer games in learning is not new but has been negatively affected by apocalyptic ideology on the effect of video gaming in the 1980's (Aguilera & Mendiz, 2003; Squire, 2003). Such thoughts can be linked to the early work of Malone (1980) but only recently made popular by Prensky (2001), Gee (2003) and Aldrich (2003). Findings from initial research studies showed that computer games can be used to acquire certain cognitive abilities and improve learners' understanding in topics presented (Aguilera & Mendiz, 2003; BECTa, 2006; Jenkins, Klopfer, Squire, & Tan, 2003). These preliminary results are convincing and have gained tremendous interest from different sectors including government, academia and industry to further explore the benefits of such opportunities (BECTa, 2006; FAS, 2006a). Many also agree that it is now appropriate to take advantage of gaming technologies to create a new generation of educational technology tools to equip learners of all ages with necessary skills through experiential learning (FAS, 2006a). It is crucial that the education sector is well-informed of the development of such innovative learning approaches and its benefits to offer high-quality education to all types of learner.

This chapter provides an overview of games-based learning by describing computer games, their application in education and training, and related terms used to describe the approach. Educational theory underpinning games-based learning, its approaches, pros, cons and challenges are then discussed before concluding the chapter with a glimpse into the future of games-based learning.

WHAT IS GAMES-BASED LEARNING?

Computer (video) games are interactive software applications created primarily for participatory entertainment purposes (Rollings & Adams, 2003). The terms 'computer games' and 'video games' were formerly referred to as PC-based games and console-based games but are now used interchangeably due to the blurring state of technology. Computer games as software artefacts combine multimedia and other computing technologies such as networking to clever use to enable the game player to experience goal-directed play in a virtual environment. A computer game can be represented by the three primary design schemas defined by Salen and Zimmerman (2003) in their conceptual framework as;

- *Rules*, which formally represent the 'mechanics' or operational constraints within the game construct, which in turn governs the level of interactivity within the game.

- *Play*, which represents the experiential aspect of the game and communicated to the game player through activities that are distinctively categorised by Crawford (2003) as interactivity, challenge and conflict.
- *Culture*, refers to the beliefs and norms represented in the game world, which is often portrayed to game-players through artificial characters, objects and settings via aural and visual representation of the game world, and through storytelling.

In summary, *rules* and *culture* define the technical and intrinsic representation of some virtual "playground" to support the activity of *play*. This conceptual framework will serve as the basis to distinguish between educational games and computer games in the next section.

The focus of computer games in entertainment has always been the activity of play, which is governed by the set of formal rules defined within some cultural context. Koster (2004) defines play as a brain exercising activity that attempts to master the ability to recognize patterns in various contexts. From a pedagogical standpoint the activity of play that game-players experience is technically a loop of doing and reflecting in a motivating context that enables them to learn to master their art. Indirectly, game-players learn by doing and such an approach helps in retaining information effectively as opposed to just receiving information in a passive manner (Roussou, 2004). Such belief is centred on 'activity theory', which assumes that consciousness and activities are inseparable (Leont'ev, 1977). More aspects of pedagogy in games-based learning will be discussed in *Pedagogies in Games-based learning* section later in this chapter.

In general, games-based learning refers to the innovative learning approach derived from the use of computer games that possess educational value or different kinds of software applications that use games for learning and education purposes such as learning support, teaching enhancement, assessment and evaluation of learners. The term 'games-based learning' can also refer to the use of non-digital games such as card games (Baker, Navarro, & Hoek, 2005) and casino chips (Cook & Hazelwood, 2002) as activity to engage and hold learners in focus by encouraging learners to participate during the lesson through game-play. More specific terms that refer to the use of computer games in learning and education include 'digital game-based learning', which was coined by Prensky (2001), and 'games-based eLearning' by Connolly and Stansfield (2007).

In games-based learning environments learners are presented with learning material in the form of narrative and storytelling and they learn through game-playing and studying the properties and behaviour of in-game components, the relationship between these in-game components and the solving of problems in the defined scenario (Tang, Hanneghan, & El-Rhalibi, 2007). From the learning theory perspective, games-based learning possesses characteristics such as:

- motivating and engaging but not necessary entertaining;
- requires participation from learners;
- has clear learning objectives defined in the game-play and scenarios presented while knowledge can be imparted through storytelling and narrative;
- scenarios defined are reflective and transferable to the real-world experience;
- provides freedom to interact in the game world through a set of defined actions;
- provides clearly defined feedback for every action taken;
- both assessment and lesson can take place during game-play;
- matches learner's pace and intellectual ability;
- highly scalable so can be used for educating large numbers of learners concurrently.

Distinguishing Educational Games from Computer Games

Computer games for use in games-based learning are generally termed 'educational games'. Computer games and educational games share many common technical features but differ in their intended use and design of content. Computer games are primarily designed for entertainment purposes while educational games are intended to impart knowledge or skills development although some educational aspects and entertainment aspects exist in both fields. Therefore the real distinction between computer games and educational games can only be further explained through the definition of the design schemas *play, rules* and *culture* based on the purpose defined.

Play in the context of computer games has always been perceived as an activity of enjoyment or recreation instead of serious or practical purpose. Contrary to computer games, *play* in the context of educational games should be defined as meaningful learning activities that promote the formation of new concepts and development of cognitive skills. These meaningful learning activities are interactions designed with an aim to educate learners through the principle of cause and effect. *Rules* and *culture* have to accommodate the direction of play defined for either purpose; entertainment or learning, or both. In fact, many well-designed computer games are indeed educational although they are lacking in the integration of knowledge and training in skills that are considered educational.

Rules that govern game-play in educational games are coupled with measureable learning objectives that are assessable via interactivity. Although computer games have similar measurable objectives, game objectives are designed to steer game-play towards entertaining play and may not be applicable in reality. Grand Theft Auto (www.grandtheftauto.com), a controversial but a very successful computer game where game-player takes on the role of criminal in a big city and participates in occasional criminal activities such as occasionally taxi driving, fire-fighting, pimping, street racing and other regular crime features such as bank robbery and assassination is an example of rules of game-play that contradicts with the norm in the society. These rules can also be in the form of distinct challenges that place demands on the learner to solve a variety of problems cognitively and possibly requiring hand-eye coordination. These challenges also exist in computer games but may be presented in a fictitious context that is irrelevant to any real-world context and may lack accuracy in representation. Mechanistic rules underlying game-play for educational games can range from simplistic to extremely complex representation (for example on a par with a true simulator) depending on the subject matter that has resemblance of reality contrary to computer games that require a playable version of mechanistic rules.

The details of *culture* in educational games depend somewhat on the subject matter and the designed learning objectives. Ideally educational games should exhibit belief and norms from some real-world scenarios to facilitate knowledge transfer from the game world to reality. However most educational games have the world set in a fantasy environment as it may increase the intrinsic motivation of learners according to Malone & Lepper (1987). In such context belief and norms should defined according to the learning objectives and reflect some degree of truthfulness and relation to the real-world to sustain the educational values that distinguish educational games from computer games. Story and narratives are often used to set the scene and immerse game-players into the game world both in computer games and educational games from various perspectives. The difference, however, lies in the defined events (game-play sessions) driven by the story whether such events are meaningful activities that would help game-players to understand the subject or a playground merely for eliciting fun. In fact it is more natural to use dialogue as a method of

storytelling and information dissemination to the game-player via artificial characters instead of narrative. Other forms of content beside narrative, such as the visual element, need not be ultra-realistic although it is desirable (but costly) to include such a requirement in educational games. Visual elements in the form of avatars and objects are sufficient for the purpose of learning. Table 1 below summarises the main differences between computer games and educational games in relation to play, rules and culture.

Some examples of educational games are *Food Force* and *Hot Shot Business*. *Food Force*[1] is an educational game published by the United Nations World Food Programme (WFP) to educate children between the ages of 8 – 13 about the fight against world hunger. Set in a fictitious island called Sheylan in the Indian Ocean players are taken through six different missions with specific learning objectives; (1) *Air Surveillance* - The causes of hunger and malnutrition; (2) *Energy Pacs* - Nutrition and the cost of feeding the hungry; (3) *Airdrop* - WFP's emergency response; (4) *Locate and Dispatch* - Global food procurement; (5) *The Food Run* - Land-based logistics; and (6) *Future Farming* - Long-term food aid projects. Simple game-play is introduced in each mission, for example, in the *Energy Pacs* mission game-players are required to purchase food items such as rice, beans, vegetable oil, sugar and iodised salt with the budget of USD0.30 per person per meal within 2 minutes.

Disney's *Hot Shot Business*[2] is a business simulation game designed for children between the ages of 9-12 to help them learn the required skills to become a successful business owner (Everett, 2003). The educational game is designed collaboratively with the Ewing Marion Kauffman Foundation, which funds education and entrepreneurship, to support its corporate curriculum. In *Hot Shot Business* game-players can choose to own various types of business such as a candy factory, pet spa, landscaping service, comic shop, skateboard factory, magic shop and travel agent. As the game progresses game-players are required to set-up the business, sell services or products, respond to market needs, price the services and products accordingly, market the services or products and compete with other competitors. Business strategies are then evaluated to reflect the game-players performance.

Table 1. Differences between computer games and educational games in purpose, play, rules and culture

	Computer Games	Educational Games
Purpose	For entertainment purposes. Context presented is mostly fictitious or fantasy based.	For learning and skills development purposes. May be a form of entertainment based on the interpretation of the learner.
Play	Interactions designed primarily for entertainment purposes with directed objectives that can be driven by storytelling. Interactions resemble the real-world interaction in a simplified or abstract approach.	Interaction designed for learning purposes with meaningful responses and measurable outcomes. Knowledge is disseminated through events triggered by specially designed interactions and dialogue.
Rules	Rules are designed to accommodate the activity of play, which are often tuned for playability rather than reflecting the real-world.	Rules are designed for specific learning outcomes that can be used to measure the interactions during "serious play". Rules can be simplified or made complex to support the activity of play.
Culture	Beliefs, norms and world setting presented visually and via narrative often set in an imaginary world that is represented artistically and often exaggerated.	Beliefs, norms and world setting presented visually and via narrative that are related to knowledge domain, reflect truthfulness and have direct and explicit relation to real-world events. Game world maybe set in an imaginary world.

Other examples of educational games designed for learners in middle school, institutions of higher learning and adults include:

- *UNIGAME* – A web-based game that encourages learners in higher education institutions to search for information, discuss topics and arrive at a consensus using a problem solving approach (Pivec & Dziabenko, 2004).
- *CyberCIEGE* – A computer game that teaches information assurance concepts through the simulation of an IT firm where learners take on the role of decision maker to satisfy the needs of virtual users while also protecting valuable information assets from cyber-criminals (Irvine, Thompson, & Allen, 2005).
- *Supercharged!* – A computer game in which learners in middle school can learn about electrostatic properties by navigating through an electrostatic maze controlling the charge of the spaceship through careful placement of charged particles (Squire, Barnett, Grant, & Higginbotham, 2004).

There is currently a larger focus on educational games for children than any other age group. This is mainly due to the early stage of edutainment research that focuses mainly on child education. In addition, many educational games are developed quicker and more cost effectively for young children since they have a lower expectation of the sophistication of the interactive content compared to teenagers and adults. Training simulators are more popular among adults especially in the field of aviation (Telfer, 1993) and medicine (Colt, Crawford, & III, 2001).

Related Terminologies and Scope

In addition to the term 'games-based learning' and 'educational games' there are other terms available to describe the use of computer games for learning. These include 'edutainment', 'training simulators' and most recently 'serious games'. Each of these terms represents different aspects of games-based learning and is used in different contexts. Therefore it is necessary to have each of these terms explained to promote further understanding of games-based learning.

Edutainment represents the integrative use of various media such as television programmes, video games, films, music, multimedia, websites and computer software to promote learning in a fun and engaging manner. It is a multidisciplinary area of research, which furthers the potential of multimedia learning that often relates to multimedia-based educational software distributed via CD-ROM but in general represents the use of entertainment elements in an educational context (Walldén & Soronen, 2004). There are obvious areas of overlap here with other areas of study such as psychology, pedagogy, interactive graphics, human computer interaction, computing and more. *Sesame Street workshop* (Revelle, 2003), *National Geographic Channel* and *Discovery Channel* are some examples of edutainment content delivered using the medium of television (although television is typically a non-interactive platform digital TV does offer some elements of interaction). *Typing software* and *courseware* are some of the typical examples of computer-based edutainment content available off the shelf. Such computer-based edutainment content is mostly produced for the children's market with low levels of interactivity due to the low expectation that children have towards the quality of content.

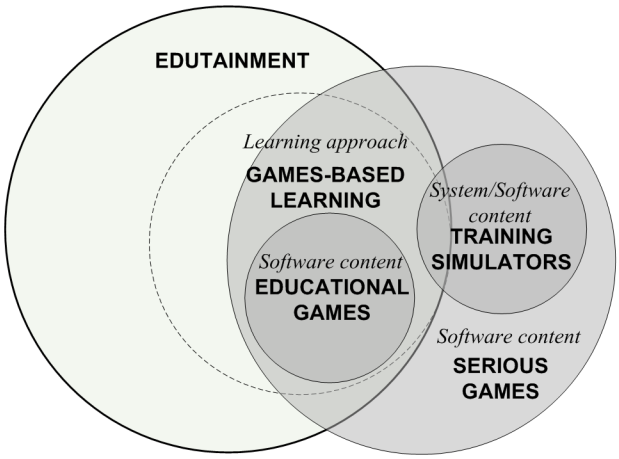
Training simulators are software systems that involve simulation of real-world experiences intended for development of skills where the challenges presented accurately replicate a real-world scenario. The user is required to solve problems using procedural actions defined through hardware interfaces (Narayanasamy, Wong, Fung, & Rai, 2006). Simulation technology was initially developed for investigation purposes in the field of science and engineering and is used to model the behaviour of some real object, machine or

system based on (near) precise mathematical modelling and highly accurate visualisation of the state of the subject over a period of time. Although training simulators share many similarities with computer games they lack elements of game-play that disqualify them from being classified as a game.

Serious games is a more recent term used to describe computer games with embedded pedagogy (Zyda, 2005). However serious games are not synonymous with educational games and training simulators. The taxonomy of serious games proposed by Sawyer and Smith (2008) expands the scope and purpose of serious games to include games for health, advertisement, training, education, science, research, production and work, in which games technologies are used specifically for improving accessibility of simulations, modelling environments, visualisation, interfaces, delivery of messages, learning and training, and productive activities such as authoring, development or production. Some serious games featured at the Serious Games Initiative website[3] demonstrate the diverse and creative application of games technology in training and creating awareness. *Food force* (WFPFoodForce, 2008), *Stone City* (Bogost, 2007), *Second life* (secondlife.com), *America's Army* (www.americasarmy.com) and *VR Therapy for Spider Phobia* (Hoffman, Garcia-Palacios, Carlin, Furness, & Botella-Arbona, 2003) are some notable examples of serious games. Some serious games may not necessarily have game-play elements but can still present educational potential. *Storytelling Alice*, a programming environment designed to motivate middle school learners (especially girls) to learn computer programming through a storytelling approach, is a good example of serious game for educational purposes. Although there is with very little elements of game-play, it is indeed an example of games-based learning in practice. In *Storytelling Alice* learners program the animated characters to act in a story they create. Kelleher (2006) reported that learners are willing to spend 42% more time in programming using *Storytelling Alice* than the predecessor *Alice* (better known as *Generic Alice*) and devote more extra-curricular time to work on their storytelling program.

Most research in games-based learning and the numerous varieties of software used in this approach are generally categorised as edutainment (as illustrated in Figure 1). Educational games, training simulators and serious games are interactive software content that takes advantage of games technologies for non-entertainment purposes with a different reach in the context

Figure 1. Relationship between and scope of edutainment, games-based learning, educational games, training simulators and serious games



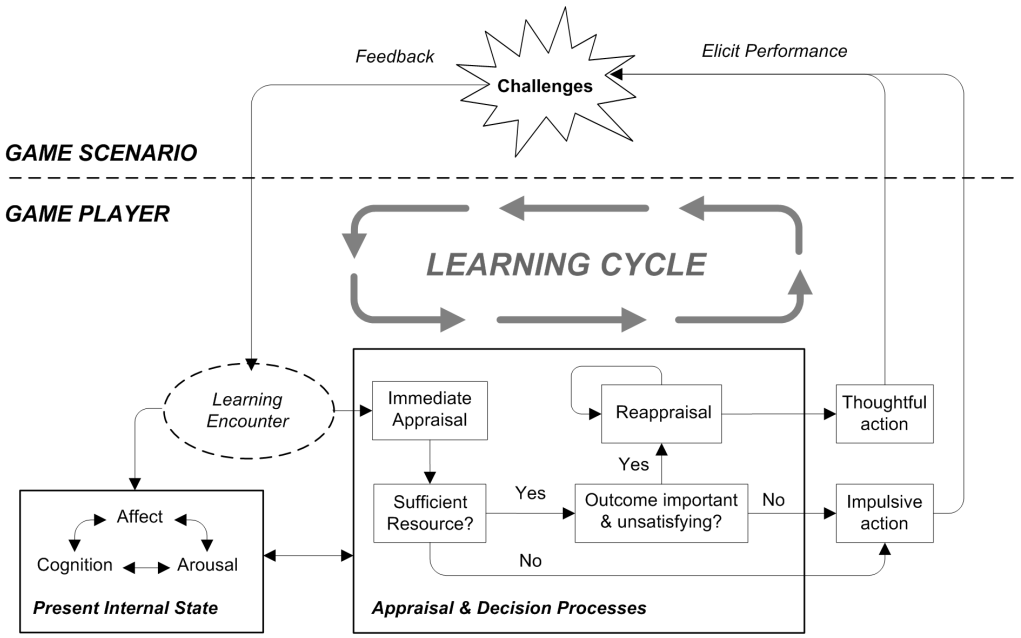
of education and training. Education focuses on the development of the mind, while training focuses on the development of specific skill sets (Moore, 1998). These are modes of learning that offer different lessons to learners and can be used in parallel in the context of learning to provide intellectual and skills development. Educational games, training simulators and serious games can be used for games-based learning depending on the appropriateness of the subject content. These terms are referred collectively as games-based learning content in this chapter.

PEDAGOGIES IN GAMES-BASED LEARNING

Games-based learning attracts learners to first learn about the game world and eventually learn about the subject embedded within the game through productive play. From a pedagogy standpoint well-designed learning games have theories of learning such as Gagne's 'Conditions of Learning theory', Gardner's 'Theory of Multiple Intelligences', Skinner's 'Operant Conditioning theory', Thorndike's 'Laws of Effect' and Maslow's 'Hierarchy of Needs theory' embedded in the design as simple 'recipes' to engage game-players to learn as they play (Becker, 2005; Siang & Rao, 2003; Tang & Hanneghan, 2005).

These theories of learning serve as a basis for a learning model in computer games described by Buckley and Anderson (2006) through their *General Learning Model* (GLM). The GLM provides a means for describing the learning process experienced by learners in the game world. The learning cycle experienced by the game player (or learner in the context of games-based learning) begins with the understanding of environmental cues presented, which are then interpreted to generate a list of short-term goals. Game-players then act according to the selected goal and evaluate the appropriateness of the action taken in relation to the goal selected. Games-based learning also integrates some of the effective and desirable learning approaches used in current

Figure 2. General Learning Model: expanded causes and processes (adapted from Buckley & Anderson ©2006)



practice. These learning approaches include *active learning*, *experiential learning* and *situated learning*.

Active learning refers to the use of interesting activities to engage and maintain a learner's focus by encouraging participation during the lesson. Activities introduced as part of active learning should encourage learners to do and question their own actions and should permit them to explore and develop their own understanding of the subject area presented (Bonwell & Eison, 1991). Games-based learning demands the user to participate in the goal-directed play and encourages the learner to practice and experiment with various solutions to the challenges and conflicts presented in a safe, virtual environment. Non-digital games (i.e. those in a non-computer form) are a recommended strategy to facilitate active learning in a classroom setting to encourage participation and foster the spirit of competition among peers (Cook & Hazelwood, 2002; Crichton & Flin, 2001; Hill, Ray, Blair, & Curtis A. Carver, 2003; Radford, 2000). As compared to conventional active learning strategies that take place mostly in a classroom setting, games-based learning can also be used outside of classroom hours individually or even collaboratively in groups via a computer network.

Experiential learning emphasises the importance of experience in the process of learning. Made popular by Kolb through his 'Learning Cycle theory' it is a useful descriptive model of the adult experiential learning process known to many educators at tertiary level. The model suggests that an adult's learning process is a cycle of four stages better described as *Concrete Experience*, *Reflective Observation*, *Abstract Conceptualization* and *Active Experimentation* (Kolb, 1984). In games-based learning, learners also use an experiential learning approach during game play. Interactivity, governed by the rules that form the play, provides learners the freedom to interact with the game objects in the game world. Responses obtained for each action is a form of knowledge (causal-effect relationship) gained through interactivity. This is often simply achievable through a single mouse-click or key-press. Repeated use of each action provides greater understanding to learners how such action is useful in a number of situations to shape the learner's experience. The simple control interface (through game pad, keyboard and mouse) and well defined and obvious (or exaggerated) responses in games-based learning contexts makes association of knowledge straightforward and less complicated compared to the real world where it is less easily recognisable. The only drawback of experiential learning is in transferring the knowledge gained in a virtual world to the real world because learners are separated through non-conventional physical objects, such as a game pad or mouse. However innovative hardware interfaces such as Nintendo's WiiMote and Sony's SIXAXIS motion sensing controller are making the gaming experience more physical and tangible and are thus bridging the gap of experience transfer to the real world.

Situated learning requires learners to be placed in a real, social and/or physical environment that enables learners to experientially learn skills and knowledge of a profession through social and collaborative interaction (Billett, 1996; Brown, Collins, & Duguid, 1989). It was proposed to address the gap between the learning of theory and the application of knowledge (Lave & Wenger, 1991). Games-based learning can virtually situate learners in any (often highly realistic) environment for learning and permit social and collaborative interactions with other learners (via online networking capabilities) and non-player characters (NPCs). Learners have the opportunity to practice their knowledge safely in this environment and review their understanding towards the knowledge constructed instantly through programmed responses. Although games-based learning does not yield the same benefits of traditional situated learning, learners can still learn from the virtual experience offered and are better prepared for the real situation.

GAMES-BASED LEARNING APPROACHES

Games-based learning can be used to supplement existing learning approaches or can be integrated into existing curricula as an extension to current e-learning systems. Both approaches have their own merits depending on the needs of adopters, i.e. whether games-based learning will add value to the learning experience or address the wider issues of human resourcing or cost in teaching and training. Selection of the right approach also largely depends on the learners' age group and the intended use of such educational technology. In general the focus of games-based learning content can be either *targeted* or *immersive* (Freitas, 2007). Games-based learning content with a targeted focus is designed to teach very specific concepts in learning, whereas immersive-focused content provides learning experience that offers more than just knowledge.

Early games-based learning projects such as BECTa's Computer Games in Education (CGE) project, the UNIGAME project and MIT's Education Arcade (Games-to-teach Project) use computer games as a supplement to existing teaching practices. Most computer games used in these games-based learning projects are designed as a form of persuasion to raise learners' curiosity and interest, and subsequently transform them to become active learners. For effective learning to take place teachers play a significant role in managing this environment when using the game paradigm (BECTa, 2006). In subject areas such as aviation, corporate finance, medicine and defence, computer games and training simulators are used as a learning platform primarily as a cost effective approach for educating and training adult learners at large. In these scenarios games-based learning is used as a platform mostly for applying concepts to practice, practicing procedures and perfecting the skills within a certain area. Although it may not seem viable for schools to replace existing lesson delivery methods with games-based learning it does make sense to extend the boundaries of learning to include subject areas that are not covered in schools, for example 'life' skills, personal hygiene and dietary awareness.

ADVANTAGES AND DISADVANTAGES OF GAMES-BASED LEARNING

Learning with computer games excites and captivates learners to learn about a subject through the use of game-play transforming from the 'dull and painful' learning experience to a fun, motivating and engaging experience. Such embedded attraction, described as the 'motivation of gameplay' by Prensky (2002), can empower learners to experience learning with an 'open heart and open mind' blurring the learning-curve associated with a new subject area. Some pedagogic advantages of games-based learning discussed include:

- Encouragement of learners to take a problem solving approach in learning (Khoo & Gentile, 2007).
- Instant feedback to correct misconceptions and promote formation of concepts thus increasing learners' understanding of a subject area (Laughlin, Roper, & Howell, 2007).
- Increased retention of information through learning by game-playing (Roussou, 2004).
- Aid in acquisition and development of cognitive abilities that are not formally taught in education (Gee, 2003).
- Younger learners can learn ICT skills through game-playing that are necessary in the 21st century workforce (BECTa, 2001).
- Fostering collaborative learning among peers (Hamalainen, 2008; Sugimoto, 2007).
- Building learners confidence and helping students with learning impairments such as dyslexia to learn (Aguilera & Mendiz, 2003; Dziorny, 2007).

- Promotes deep learning by arousing learners curiosity on certain subjects (Gee, 2003).
- Transforming entertaining play to productive play and extending learning into gaming (Pearce, 2006).

From a purely financial viewpoint, games-based learning can be a cost effective approach to conduct education and training for domains such as medicine and national security that may involve expensive or dangerous equipment or material that may jeopardise the safety of learners due to mishandling. Games-based learning that demonstrates simulation characteristics can offer a 'mistake-friendly' learning environment according to Kriz (2003) and that encourages learners to experiment their solutions in the game world and raise their curiosity on a subject matter. Learners can afford to make mistakes and learn through those mistakes and restart the entire lesson whenever necessary without consequence. From an institutional and organisational viewpoint games-based learning is also a perfect platform to address the increasing need of qualified teachers to educate and train the new generation of learners since computer games are widely accepted and can be easily distributed (for example, using Internet delivery).

Games-based learning also has its disadvantages. Opponents of games-based learning have adopted a somewhat apocalyptic ideology on the effect of computer gaming that purports game-playing as a means to promote aggressive behaviour (Anderson & Bushman, 2001), smoking (Kasper, Welsh, & Chambliss, 1999), obesity (Subrahmanyam, Kraut, Greenfield, & Gross, 2000) and poorer academic performance (Hauge & Gentile, 2003). In recent years, more concrete results on the effects of game-playing has been presented, mostly related to violence and aggression behaviour (Anderson & Bushman, 2001; Anderson et al., 2004; Carnagey & Anderson, 2005). Further findings on the effects of game-playing particularly in studies of violent computer games reveal that game-players have evidence of numbness towards violence that may suggest a possible transitioning of violent behaviour to reality (Carnagey, Anderson, & Bushman, 2007). Many question the validity of the evidence presented by detractors of computer games based on the studies of media violence (Barker, 2001; Squire, 2002) and instead believe that the unintended effects of game playing are dependent on social and cultural factors (upbringing) of game-players. Also violence in computer games is widely misinterpreted as an agent for aggression as opposed to entertainment, which is what is actually experienced by game-players when they are aware of the consequences of such acts in real life (Dawson, Cragg, Taylor, & Toombs, 2007). In addition, some male students might just exploit such environments as a playground as observed in MIT's Games-to-teach project (Jenkins, Klopfer, Squire, & Tan, 2003) and BECTa's Computer Games in Education Project (BECTa, 2001).

CHALLENGES FOR GAMES-BASED LEARNING

Positive findings from earlier games-based learning projects are paving the way for more to adopt this learning approach. However there are great challenges ahead that require attention from stakeholders before learners can fully reap the benefits. The adoption of games-based learning is a challenge on its own as it requires teachers to have access to computers with 'gaming specification' (usually a high-end machine), technical support, familiarity with the games-based learning content, adequate preparation time, an appropriate audience group and the cost of licenses for games-based learning content (Freitas, 2007).

Initial findings from a related research study also indicate that there is a need to address the source of games-based learning content (Tang & Hanneghan, 2005). Development of games-based

learning content may require a huge budget and such financial barriers have been a major challenge for many teachers who intend to adopt it. Some have tried sourcing such content from commercial-off-the-shelf (or *COTS*) games and this has proved very challenging to get the right content for use in an educational setting. Most COTS games available are designed specifically to entertain and some even elicit violence and sexual content, thus rendering them inappropriate (but this does not imply useless) for use in an education context (Tang & Hanneghan, 2005). The other alternative then is to spearhead in-house development of games-based learning content using open source or royalty-free game engines and 'modding' (modifying) COTS games by utilising a game editor application to create customised game objects and levels. Almost all options available require technical knowledge, which precludes most teachers whose main aim is to solely impart their knowledge rather than become games programmers. It is evident that there are very few tools available to support development of games-based learning content for the non-developer user group.

Designing games-based learning content is another challenge that requires rigorous *design-play-test-evaluate* cycles. The unintended effects of computer gaming may still exist in games-based learning content depending on the intentional use of such a medium and appropriateness of the activities and content presented in that medium (Buckley & Anderson, 2006). Therefore it is crucial that games-based learning content is designed from sound pedagogical theories instead of focusing on entertainment value (Tang & Hanneghan, 2005; Tang, Hanneghan, & El-Rhalibi, 2007).

The duration of the game-play session may also be an issue as lessons are typically scheduled in slots of no more than one hour. Computer games are designed to be highly engaging, therefore an hour of games-based learning may not be enough to satisfy the needs of learners, but more importantly will they be able to learn within this period of time? Therefore it is justifiable if games-based learning is integrated into the curricular framework to aid learning and cater for different learning styles as proposed by Malone (1980).

The choice of a pedagogical approach has significant impact on learning. Preliminary evaluation of computer games in education reveals the possibility of inhibiting learning as reported in Hailey & Hailey (2003) and Halttunen & Sormunen (2000). As computer games may appeal to some but not all, there is a need to investigate into the appropriateness of using computer games in the design of the curriculum to maximize the positive learning experience.

FUTURE DIRECTIONS OF GAMES-BASED LEARNING

There is a significant amount of effort promoting the use of computer games in learning both from education, industry and even government. Computer games are now a ubiquitous part of a modern digital life throughout the world and exploiting this platform for use in learning can be of great benefit to all. While other attempts such as e-learning and multimedia learning have in some parts failed to engage learners, computer games are designed to be alluring and extrinsically motivating for game-players. This platform can also help teachers who are constantly challenged by the newer generation of learners and their needs in learning to provide high-quality education.

Although there are different views about games-based learning, there is a general consensus that computer games can be used as a medium for learning based on the positive findings from early games-based learning projects. However, there is a lack of empirical studies to testify to the success of games-based learning at present. More research into the potential and limitations of games-based learning is required to develop a greater understanding on the application of the technique and its impact on society. Aligned with

such vision, the Federation of American Scientist (FAS) (2006b) has identified two focussed research areas; design of games-based learning content and adaptation of simulation to learning environments, that will drive games-based learning forward. For games-based learning to be widely accepted there is a need to address the challenges discussed and more of these will be discussed in greater detail in the remaining chapters of this book.

The adoption rate of games-based learning is currently low in the education sector in contrast to the corporate sector. This is mainly due to constraints of a financial, infrastructure and working practice nature. However acceptance rates are improving year on year. In the UK, close to 60% of teachers want to use computer games in the classroom for educational purposes (Futurelab, 2006) and such statistics will continue to grow with more realising the potential that computer games hold. The availability of programming-free and user-friendly development tools that facilitate teachers in the development of games-based learning content is also highly desirable to encourage adoption by non-games practitioners (Tang, Hanneghan, & El-Rhalibi, 2007). Alternatively the education sector may consider collaboration with industry partners to jointly develop games-based learning applications. This is slowly becoming a viable option through the growth of a serious games industry that has been born out of the commercial entertainment games market as large games studios look to diversify their talent.

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ENDNOTES

1. Food Force is available for free download from www.food-force.com
2. Hot Shot Business can be played online at www.hotshotbusiness.com
3. The Serious Games Initiative website can be found at http://www.seriousgames.org/