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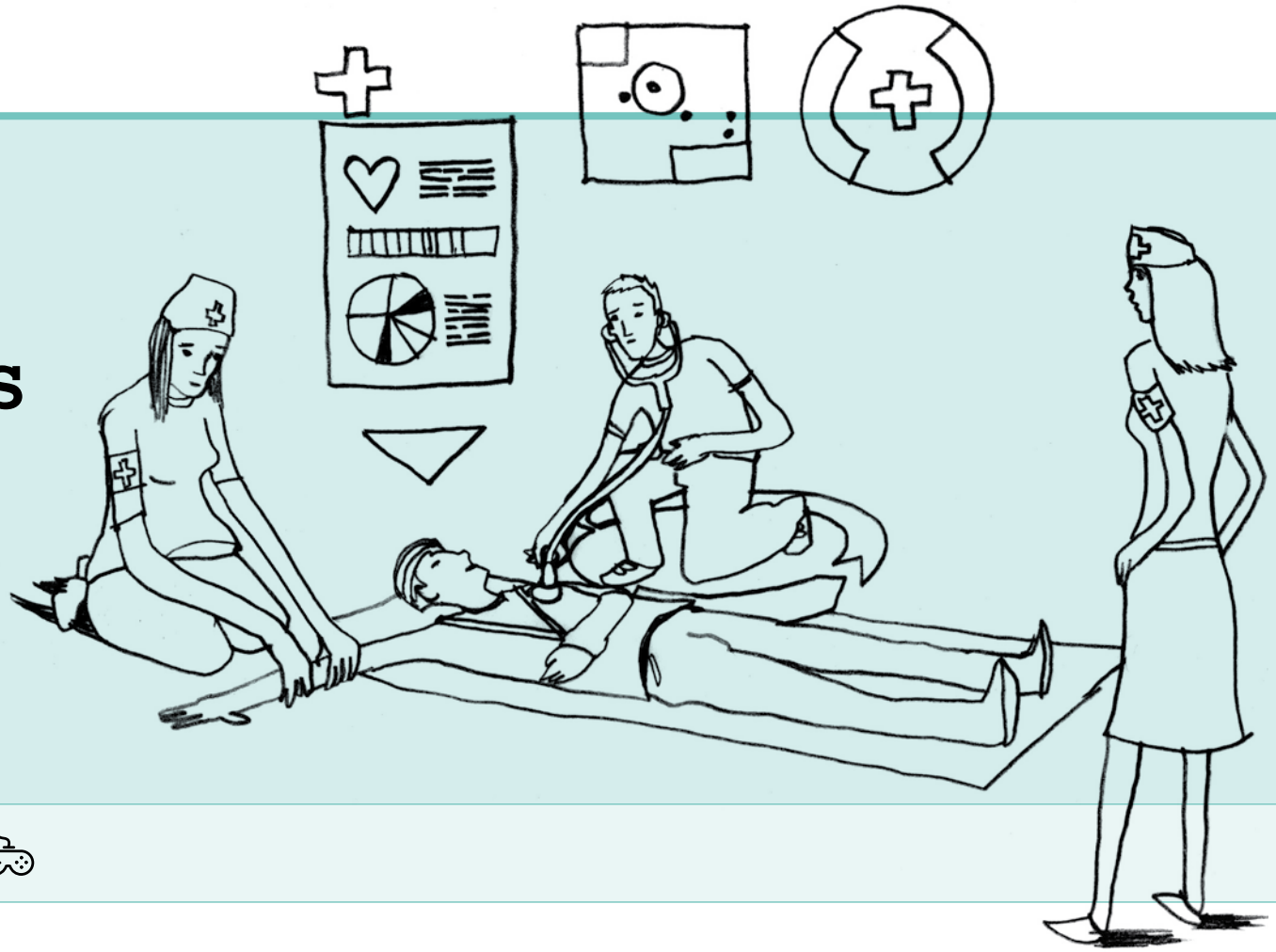
# Games in Education: Serious Games



A FUTURELAB LITERATURE REVIEW

# Abstract

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It is argued that digital games, including simulations and virtual worlds, have the potential to be an important teaching tool because they are interactive, engaging and immersive activities (for example see the work of Gee 2008; Shaffer 2005; Smith 2007). This document considers this claim. It begins by briefly considering the rationale for using games in education – informal and formal. It then considers the various types of digital games that are described as being educational, specifically:

- the relationship between games, serious games, simulations, educational simulations, and virtual worlds
- the definition and usefulness of the term serious games
- the underlying pedagogy in education games
- assessment within games.

The report then has an overview of their current use and research around their usage in multiple environments: the military, health, informal, vocational and formal education settings. It looks at the challenges of embedding serious games in formal education and three current methods for assessing appropriateness and effectiveness of games for teaching. From this it argues that what is required is a toolkit for educators, game designers and policy makers that allows the design and assessment of games to be used with an educational goal.

**Acknowledgements**
Thanks to Peter Harrington from Sim Venture and Phil Warren from Snaith School who contributed to the case studies in this document. Thanks also to all those who gave their time for the interviews: Richard Bartle, Diane Carr, Ian Dunwell, Simon Egenfledt-Nielsen, John Hoggard, Mary Matthews, Hannah Rowlands and Peter Stidwell.



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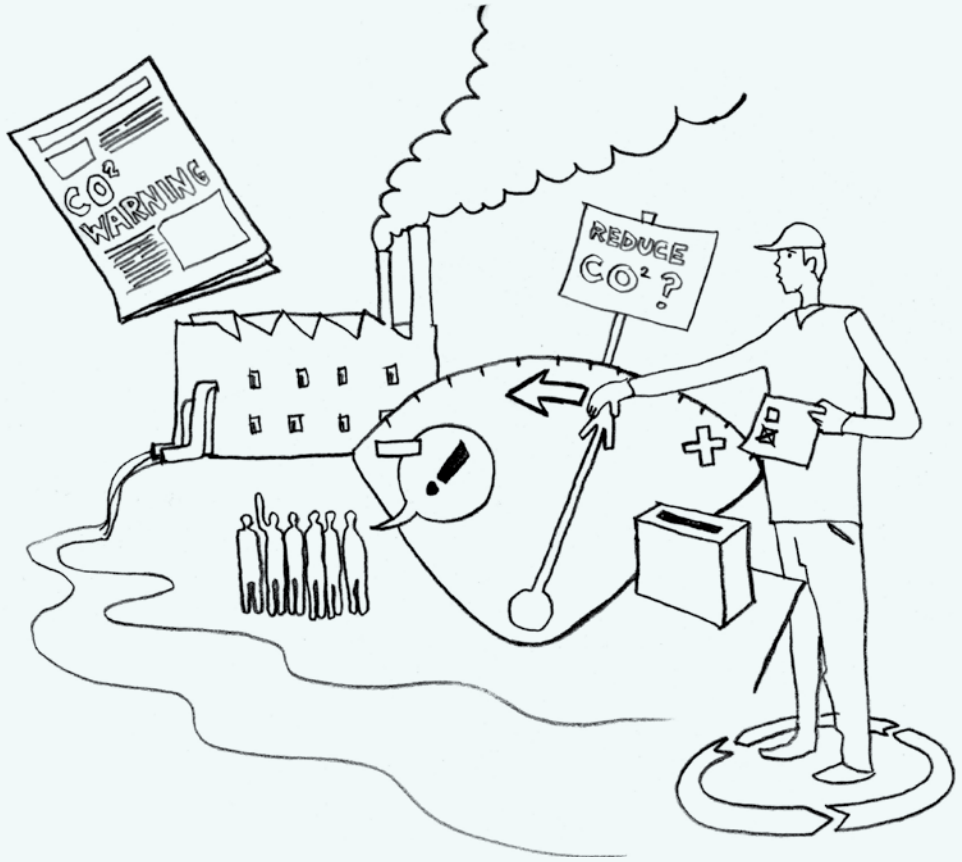
# Contents

# Executive summary



This report is a review of research around gaming environments for education; this includes games, serious games, virtual worlds and simulations. These games are used widely outside of formal education systems, for example by the military and within the health and commerce sectors. Yet their use within schools is less common. This section summarises their current use and how teachers could be supported to use them appropriately.



Identifying games that can be used for education is complex. There are many definitions and ways of classifying educational games, serious games and their relationship to virtual worlds and simulations. Some view them as a continuum (Aldrich 2009), while others see them all as different categories of the same thing (Sawyer & Smith 2008). Serious games are the accepted term for games with an educational intent. They need to be engaging, although not necessarily fun, while the learning can be implicit or explicit. There is no uniform pedagogy within serious or educational games; earlier games tended to be based on a behaviourist model. Later games try and incorporate experiential, situated and socio-cultural pedagogical models. The learning outcome is dependent upon an appropriate pedagogy **and** the underlying game mechanics **and** how the content is integrated into the game so the learning is intrinsic to play.

A comparison of the use of serious games (including simulations and virtual worlds) in multiple domains was made. The aim was to determine if the practice could be transferred to the formal educational domain.

Serious games, particularly training simulations, are integral to the military. They provide a safe cost-effective mechanism for training tasks to be performed in hazardous circumstances or which would be time and labour intensive to set up in the real world. The high level of fidelity, that is, their close resemblance to actual events, enables transference (Stone 2008). Learning is predominantly mediated through instructors externally to the game experience, although players can "win" or "lose". The ability to modify the scenario to ensure fidelity is key.

Serious games in the health sector are also a growing domain. Like the military, training simulations are becoming more common for medical practitioners. Realistic role-play is time and labour intensive and traditional methods of teaching, such as card sorting, lack the psychological fidelity – that is, they do not mimic the responses that the real situation would cause. Such games are also likely to make use of alternative interfaces. The Wii Fit has been recognised as a way of training players in certain appropriate behaviours that will benefit their health. Again like the military the games tend to have clear well-defined learning goals although there is no fixed answer.

Pulse!!: a serious game for learning complex medical practices and technical knowledge, including diagnosis of illnesses, ER services and complex surgical procedures.
**www.breakawaygames.com/serious-games/solutions/healthcare/**

The use of serious games in commerce is also increasing. They are used to train staff via simulations, and, as in the other domains, popularity is increasing due to the cost benefits. However, commerce is aware that games develop skills needed in everyday life, like confidence in taking risks and improving communication across the organisation. They also take advantage of the fact many new employees understand the concept of games and appreciate the flexibility when carrying out learning exercises.

Games also have a vocational potential. Simulations are used for continuing professional development and training. They may also be useful for young people not in education, employment or training (NEETS). They can act as a safe introduction to various vocational careers – failure is not an issue, in fact it is expected, when learning a game (Squire 2005).

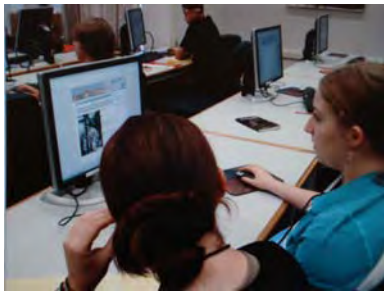
Serious games for informal learning are also proliferating due to increased commissioning. Channel 4, the Parliamentary Education Group, DEFRA and the US government (who held a competition around games for health) are commissioning games to engage and educate young people. They are used because of the high level of gaming that occurs within these age groups, the cost effectiveness and reach that games have. Unlike vocational training or formal education there is less direct assessment of the learning that occurs in these games.

Finally, in formal education there are examples such as the Consolarium, or the work of Kurt Squires, where games used with sufficient support are shown to be motivational and an aid to learning high level or complex skills. Some researchers, notably Gee and Shaffer, argue that games, particularly epistemic games that model professional practice, are good for teaching and assessing because the best commercial games provide appropriate challenges, they build on previous information, they require problem solving and critical thinking. This practice has not yet transferred to the classroom. This, they argue, is because games teach and assess 21st century skills, such as problem solving, collaboration, negotiation etc that are not the foundation of the current education system. Currently games are more likely to be used if they can be seen to inspire, or there is a direct link to the curriculum. The latter is more likely if the game can provide appropriate assessment and fits into existing lesson structures. The criterion for using a game is often whether it will make the teacher's life easier.

Games teach and assess 21st century skills, such as problem solving, collaboration and negotiation.

In order to determine if the game will make life easier the teacher needs to assess whether the game will enhance their students' learning. This requires time to learn and comprehend the game. To determine if this selection process could be supported, three models designed explicitly for developers of serious games were examined. The aim was to determine aspects already identified, and corroborated by other research, for example the Teaching with Games project (Sandford et al 2006) that needed to be considered by teachers to select, assess and blend games into current teaching practice. The areas for consideration identified for any game outside the physical constraints (available machines, licenses etc) are:

- What is the background of the player(s) (age, language, experience, prior knowledge, preferred learning styles, etc)?
- What are the learning goals?
- How does the game content, that is, the factual knowledge contained, experiences, mechanics and activities, relate to the learning goals?
- How integral is the content to the game mechanics, processes, experience of playing as well as the art assets or copy, and is its acquisition required in order to progress?
- Will the game engage the learners – is it immersive?
- Does the game have a learning curve (ie do the players improve through repeated play), appropriate feedback, clear progression etc?
- What level of fidelity is appropriate?
- How will learning be transferred beyond the game context?
- How can the game be embedded and assessed?
- What other practices will support learning, either in the game such as reflection, or externally such as discussion?
- What retention rate, ie how long will the players remember the learning, will the game have?



Urban Science: players become urban planners to learn about civics and ecology. **http://epistemicgames.org/eg/category/games/urban-planning**

However, further research is needed to create a simple set of metrics for evaluating each of these areas, rather than just highlighting their importance.

If games are to become mainstream classroom tools teachers (who are often not gamers) need support to:

1. identify what games are available that meet their learning objectives

2. how they can best be integrated into lessons given the context and

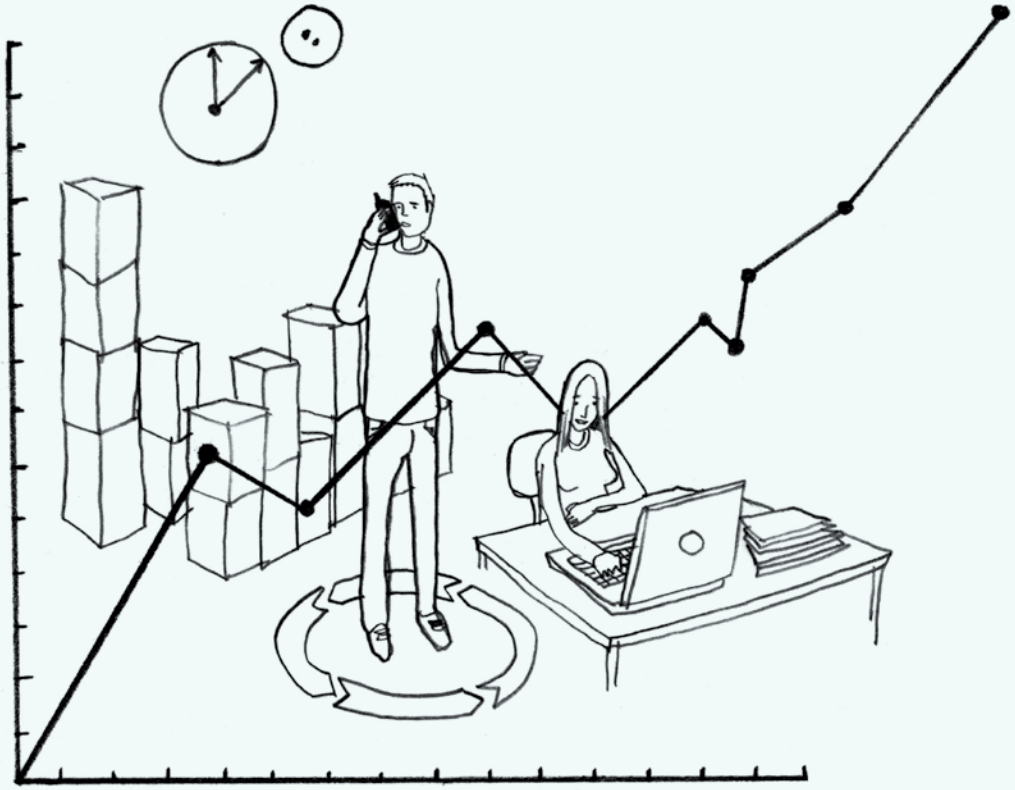
3. how learning can be assessed.

Such metrics need to be shared by teachers and developers so there is a common language to describe and use games.

Further support is required to make the use of games widespread in school.

# Introduction

There are many advocates for the role that games, particularly serious games, could play in formal education. In this report we look at whether these claims can be justified, through looking at aspects including the underlying pedagogy in education games, assessment within games, and considering three models for designing, selecting and evaluating serious games in order to determine the criteria needed for selection and use.



"There will inevitably come a time when no one alive remembers a time before video games existed. Like books and movies, they will be a part of the media landscape older than living memory. Within a modern school, that time has already arrived: every single pupil was born into a world where video games were simply a fact of life, and it's in this environment and among these pupils that the serious potential of video games suddenly starts to seem less a novel possibility than a creeping inevitability – as much a fixture in our future lives as the mobile telephone or the computer screen." (Chatfield 2010, p199)

Tom Chatfield's argument illustrates the expectation that digital games[01] will become teaching tools within the classroom. Just as teachers and students, especially those in higher education, are designing and using courses that utilise mobile technology, so courses will develop that utilise game play.

Research groups are emerging that are looking at digital games in the classroom. The Games for Learning Institute (GfLI) was set up at New York University in 2008 to study what makes computer games engaging and educationally effective[02]. Also in New York is the Quest to Learn secondary school, which uses and is investigating the format of games as its pedagogical model[03]. A third example is the Epistemic Games Group[04] that arose from the Wisconsin-Madison University with its interest in games that model professional practice. In the UK there is the Serious Games Institute in Coventry[05], although this has a broader remit than just the classroom.

This interest in digital games designed for learning is not restricted to formal educational practice; games specifically for learning exist in domains as diverse as the military, commerce, health and informal learning. The Serious Games Summit has been ongoing since 2003; this year was the sixth Games for Health conference, there are discussions within the Digital Games Research Association (DiGRA) and in their associated library, and within Gamasutra (an organisation primarily for developers which focuses on the art and business of making games). In addition there are journals that focus on the use of games, digital and more traditional, as teaching tools. For example, the online Games Study journal, Games and Culture, the more recent International Journal of Gaming and Computer-Mediated Simulations (IJGCMS)and, from 2011, the International Journal of Game-Based Learning[06].

**01.**
For the sake of simplicity in this document the terms video games, digital games, and games are used interchangeably. Unless specified these terms are used to include single and multi-player games played on a variety of platforms (consoles, PCs, portable devices, etc) which can be standalone or online. Where specific distinctions are needed, such as traditional games (board game, sports etc), these will be made in the text.

**02.**
This group is headed by Prof Ken Perlin; it consists of thirteen primary investigators from seven U.S. universities as well as research staff. The group has financial, software and advisory support from Microsoft External Research and Motorola. See **http://g4li.org/about**

**03.**
Details of the pedagogy used by the school can be found at **http://q2l.org/node/13**

**04.**
Epistemic games are authentic tasks in which students are apprenticed to a profession, and use that profession's tool kit of knowledge, skills and values in order to produce the products that those professionals produce. See **www.epistemicgames.org**

**05.**
See **www.seriousgamesinstitute.co.uk**

**06.**
**www.gamestudies.org**

**http://gac.sagepub.com**

**www.igi-global.com/bookstore/TitleDetails.aspx?TitleId=1125**

**www.igi-global.com/Bookstore/TitleDetails.aspx?TitleId=41019**

Thus there are many advocates for the role that games, particularly serious games, could play in formal education. In this report we look at whether these claims can be justified. Even if this potential is assumed, which is a question addressed in the report, there is still the need for educators and trainers, learners and policy makers to appreciate how and when these games are useful. As pointed out by Mayer and Bekebrede:

"We often falsely assume that the game itself will be powerful enough to cause change or learning that the outcomes will be used automatically for decision making. This is seldom the case"
(Mayer & Bekebrede 2006, p.150)

In order to begin to appreciate these areas and scope potential for future work this report focuses on:

- the rationale for the research.
- the relationship between games, serious games, simulations, educational simulations, and virtual worlds. This includes sections on: the definition and usefulness of the term serious games, the underlying pedagogy in education games, and assessment within games.
- considering the use of serious games in various contexts, including formal education, to identify their efficacy and any issues or benefits of their use analysing the difficulties in incorporating games into the formal educational system. This includes considering three models for designing, selecting and evaluating serious games developed for game designers, content specialists, and teachers in order to determine the criteria needed to select and use such games.

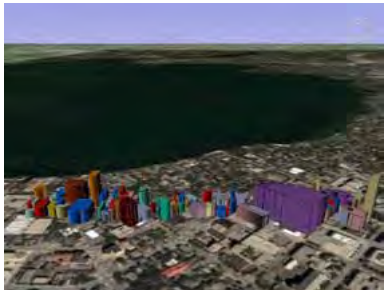
Quest Atlantis (QA): an international learning and teaching project that uses a 3D multi-user environment to immerse children, ages 9-16, in educational tasks.
**www.questatlantis.org**

The report concludes with recommendations for further work.

Material in this report is based upon relevant literature and eight expert interviews. The interviewees came from: research, design and development, commissioning, and those that use games. To illustrate the range of games this report contains three case studies of serious games used for various purposes: triaging patients, entrepreneurship, and issues around climate change. It is to be read in parallel with other Futurelab research in Games and Learning[07]. Therefore it focuses on serious games rather than revisiting issues around e-safety, or marketing of such games which has been previously covered.

This 'Games in Education: Serious games literature review' is designed to introduce policy makers and educators to:

- digital games for education, including serious games and their structure
- current methods and cultures within which serious games enhance learning
- processes for selecting games.



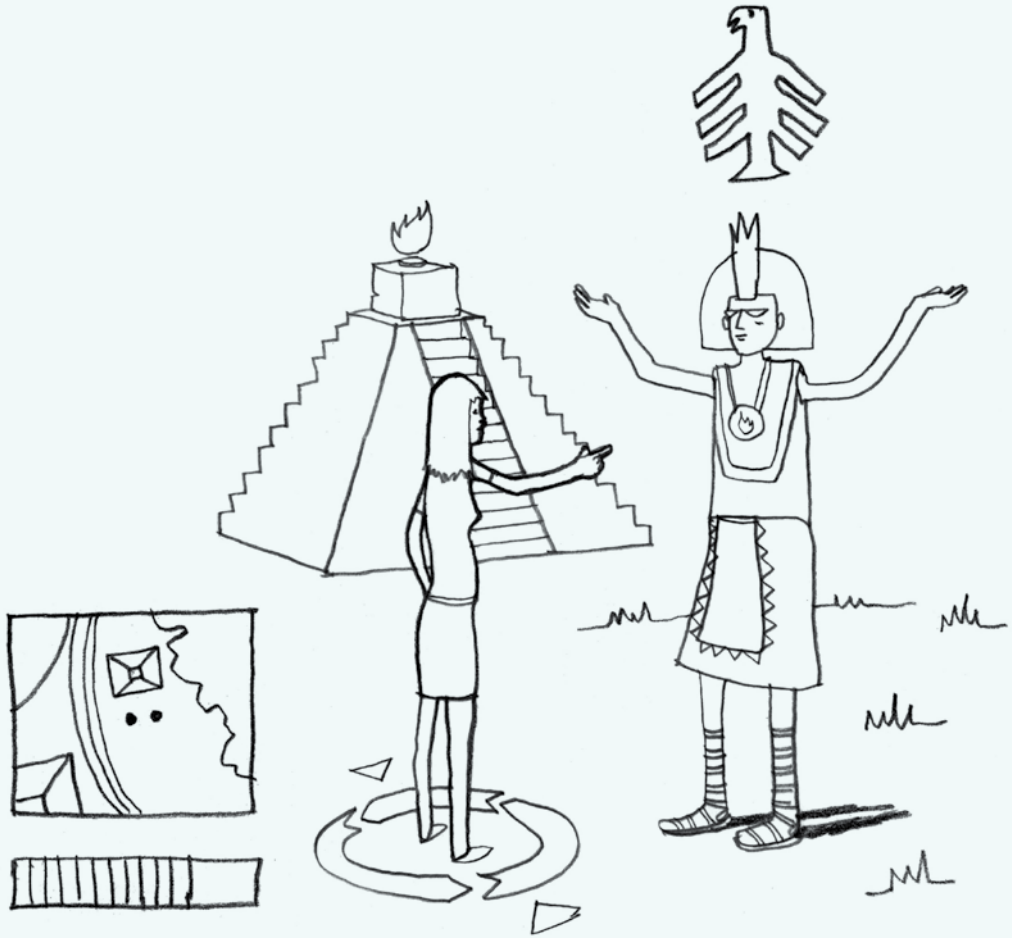
Urban Science: players can present their final plans as a three-dimensional model of the redesigned city.
**http://epistemicgames.org/eg/category/games/urban-planning**



**07.**
See **www.futurelab.org.uk/projects/games-and-learning**.

# Context

This chapter begins by defining the assumptions made about games, game playing, and games as tools for teaching and learning. It then describes the motivation for the research, definition of serious games and the relationship between different definitions. It also looks at how these tools can relate to pedagogy, and how they can be used for assessment.



# Rationale for research

The intentional use of games as learning tools is not new. Non-digital games are used for learning social, physical, and psychological skills, for example, coping with the emotions after losing, learning the ground rules for appropriate behaviour, and modelling the behaviour of adults. Traditional board games and role-play as a tool for formal learning, that is, learning defined by a curriculum, existed before the arrival of digital games. The Inter-Nation Simulation was introduced in 1958 to teach international relations to high school students, and a few years later the Sumerian Game, a simulation to teach the economic factors in Mesopotamia around 3500BC, was used with 11 year olds (Simon Egenfeldt-Nielsen et al. 2008, p.209).

Futurelab, along with other organisations[08], has been investigating the role that games play in formal education. Futurelab's work has included examining the potential of commercial off-the-shelf leisure games in the classroom along with bespoke educational games such as Racing Academy and Space Mission. This work, along with surveys on game usage outside of schools, has established that:

– Without claiming that every child is a gamer, or even interested in gaming, games are integral to many young people's lives[09].

– There is a growing acceptance amongst teachers that games have educational potential and there is an increasing willingness to use games in their classroom[10].

– Games provide a platform for active learning, that is, they are learning by doing rather than listening or reading, they can be customised to the learner, they provide immediate feedback, allow active discovery and develop new kinds of comprehension. There is also evidence of a higher level of retention of material[11].

**08.**
Such as Simon Egenfeldt-Nielsen, the Epistemic Games Group and those at the University of Wisconsin-Madison, and David Buckingham.

**09.**
For example, the O2 2009 survey showed that the average household had 2.4 TVs, 1.6 laptops/Apple Macs, 2.4 games consoles, 3 mobile phones and 2.2 MP3 players . While the 2009 Today's Gamers Survey found there were 31.3 million people who play games in the UK (this includes playing any game on consoles, computers, and mobile devices), and that they spent £3.78 billion on games in the last year, with the largest proportion being console games (£2.39 billion). The remainder is spent on PC games, game portals (eg social networks), massively multiplayer online games and mobile games in that order.

**10.**
In 2009 as part of a self-completion survey of over 1,600 practicing classroom teachers in English state primary and secondary schools 35% said they had used games, and 60% would be willing to do so in the future. The questions were designed by Futurelab and the survey conducted by the National Foundation for Educational Research (NFER) through its February 2009 Teacher Omnibus.

**11.**
Magennis and Farrell (2005) reported that students who learn by doing have an average retention rate of 75% compared to an average retention rate of 5% for those who learn from lectures. While Joyce (2005) found a retention rate of 90% from simultaneously seeing, hearing, and doing, 80% from doing, 40% from seeing, and 20% from hearing (cited by BinSubaih et al. 2009, p.9).

– Students are often motivated and engaged in games in a way that they are not with formal educational practices[12].

– Games form only one part of teaching practice and should be used as part of a blended learning approach, that is, as one method of conveying and assessing learning amongst others (de Freitas & Oliver 2006; Klawe & Phillips 1995; Šisler & Brom 2008).

– The technology upon which games are used and played is improving, for example there is more access to greater broadband speeds, improved graphics cards and storage space and a higher uptake of digital devices overall.

– There is an expectation that the types of interaction within games will increase with the introduction of speech, haptic or neurological interfaces, and in the future the potential for integrating chat-bots, mashing up sources and scaffolding learning via agents will be realised[13].

Digital games use in the classroom is not new. Tim Rylands, who won the 2005 Becta ICT in Practice Award, has used Myst for the last ten years to inspire students. Another often cited example is Learning and Teaching Scotland. In 2006 Derek Robertson introduced the Consolarium. Initially a physical space, this programme advocates and supports (both in terms of kit and practice) teachers to use digital games as learning tools[14]. This would overcome some of the barriers teachers cite – cost of games and hardware, time to learn the game to ensure that it is used appropriately etc. Another is the work of Steve Bunce and Anna Reid who as part of the Becta sponsored Harnessing Technology project, have used Nintendo DS's to develop the use of enquiry for Northumberland County Council[15]. Practical advice on games use in the classroom has been developed from the framework of European Schoolnet's Games in Schools project (Felicia 2009). As previously mentioned Katie Salen and colleagues at the Institute of Play in New York have set up the Quest to Learn middle school[16]. Although lessons are not necessarily based around digital games, the principle of learning through gaming is applied across the curriculum.

12.
Gee (2003) is an example of a researcher who believes games are inherently motivating, yet Kurt Squire found that games in the classroom can be avoided by pupils who cannot adapt to this educational use (Squire 2005).

13.
For a discussion of this see the Sara De Freitas talk at the 2010 Games Based learning conference, **www.gamebasedlearning.org.uk/component/option,com_smf/Itemid,58/topic,89.0**

14.
See **www.ltscotland.org.uk/ictineducation/gamesbasedlearning/aboutgbl/consolarium.asp** for a description of the project.

15.
The work is described in the Becta research report at **http://research.becta.org.uk/index.php?section=rh&catcode=_re_rp_gr_03&rid=17952**

16.
For a description of the principles behind the school see **http://q2l.org/node/2**.

In order that this body of research around commercial games in the classroom or the advantages of game-based learning in general is not replicated, this report focuses on digital games with an educational intent, often called serious games. Why this focus? Through their design, research based serious games are meant to achieve specific learning goals (Egenfeldt-Nielsen et al. 2008). These games are structured so that the learning goals can be recognised and the learning can be transferred to other contexts. This recognition and transfer is an issue when using leisure games for formal learning (Gee & Shaffer 2010; Baker & Delacruz 2008; Egenfeldt-Nielsen et al. 2008). Yet despite this serious games are infrequently used within the educational system, although are increasingly popular in adult training and out-of-school learning experiences (de Freitas 2006; JISC 2007; BinSubaih et al. 2009). If serious games are to be advocated it is necessary to know why. Are they used rarely because they are not yet fit for purpose? Is it to do with the method of teaching within schools? How policy makers advocate their use? The quality of the games and relationship to curriculum? Or the ability and knowledge of the teacher?

Before addressing these questions it is important to understand what serious games are. This terminology is frequently and inconsistently used, and without an understanding of the underlying pedagogy and the assessment techniques they employ recognising appropriate use will be problematic. In the next section the definition, the pedagogy and the assessment are discussed.

This report focuses on digital games with an educational intent, often called serious games.

# Serious games, sims, and virtual worlds: How they relate

Are serious games, simulations and virtual worlds the same? Clark Aldrich (2009) sees virtual worlds, games, and simulations as points along a continuum. All are highly interactive virtual environments (HIVEs), all with their own affordances and purposes. The three can look similar, Aldrich states all can be set in 3D worlds with 3D avatars but:

**Educational simulations** use rigorously structured scenarios with a highly refined set of rules, challenges, and strategies which are carefully designed to develop specific competencies that can be directly transferred into the real world.

**Games** are fun engaging activities usually used purely for entertainment, but they may also allow people to gain exposure to a particular set of tools, motions, or ideas. All games are played in a synthetic (or virtual) world structured by specific rules, feedback mechanisms, and requisite tools to support them – although these are not as defined as in simulations.

**Virtual worlds** are multiplayer (and often massively multiplayer) 3D persistent social environments, but without the focus on a particular goal, such as advancing to the next level or successfully navigating the scenario.

The continuum is shown in Figure 1.


Nexus US: a graphic simulated experience that can be shared with geographically dispersed teams of people for training and education. **www.ecsorl.com**

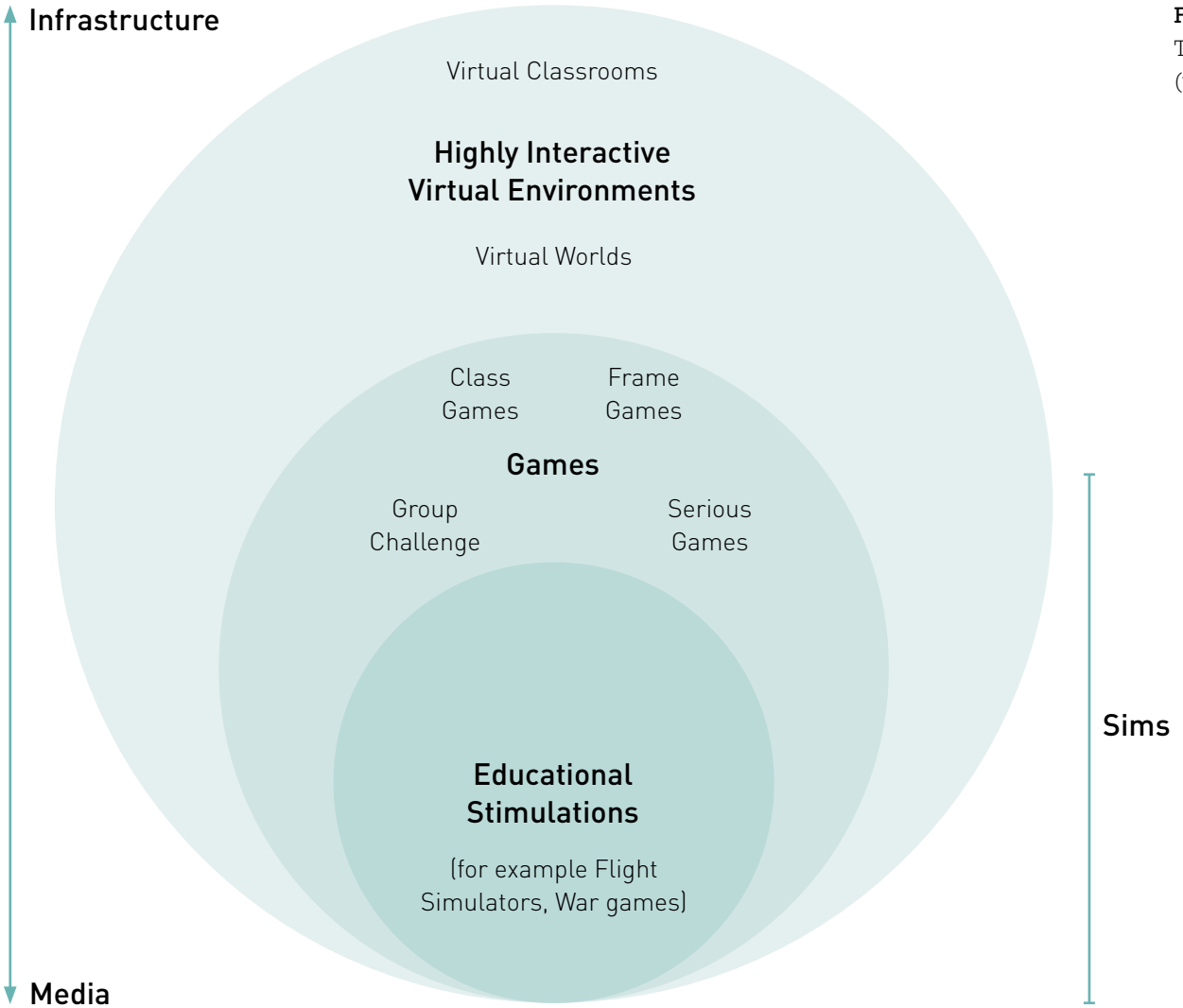



**Figure 1:**
The HIVE continuum
(taken from Aldrich 2009, p1)

Aldrich goes on to distinguish the differences between the three further.

"A virtual world will not suffice where a simulation is needed. The virtual world offers only context with no content; it contributes a set of tools that both enable and restrict the uses to which it may be put. An educational simulation may take place in a virtual world, but it still must be rigorously designed and implemented. Organizations routinely fail in their efforts to access the potential of virtual worlds when they believe that buying a virtual world means getting a simulation. Likewise, a game is not an educational simulation.

"Playing SimCity will not make someone a better mayor. Some players of, for instance, World of Warcraft may learn deep, transferable, even measurable leadership skills but not all players will. The game does not provide a structure for ensuring learning. Just because some players learn these skills playing the game, that does not mean either that most players are also learning these skills or that it should be adopted in a leadership development program. Conversely, a purely educational simulation may not be very much fun. The program may have the three-dimensional graphics and motion capture animations of a computer game, but the content may be frustrating. Specific competencies must be invoked, and students' assumptions about what the content should be, likely shaped by their experiences with games, will be challenged." (2009, pp.2-3)

Those at the Institute of Education agree with the distinction. Virtual reality, for example Second Life, is not a game because it lacks the features used in a game study definition, such as games are played, have various modes of play and they incorporate goals, chance, rules, and discernable outcomes. Games have a story or purpose, certain game mechanics (for example how the game world behaves in terms of physics or weather), rules, the graphical environment (the sensory representation of the experience of playing), interactivity, and a sense of challenge or competition (Derryberry 2007). The Institute of Education research concludes there are: "interesting questions about our reliance on structure-orientated definitions within game studies, and the 'grey area' where games and play combine" (Carr et al. 2010).

An educational simulation may take place in a virtual world, but it still must be rigorously designed and implemented.

However, although Aldrich places serious games within games his is not an opinion that is shared. Alke Martens and his colleagues believe that game-based training (their terminology for serious games) requires a game, simulation and learning aspect in almost equal measure (see Figure 2).

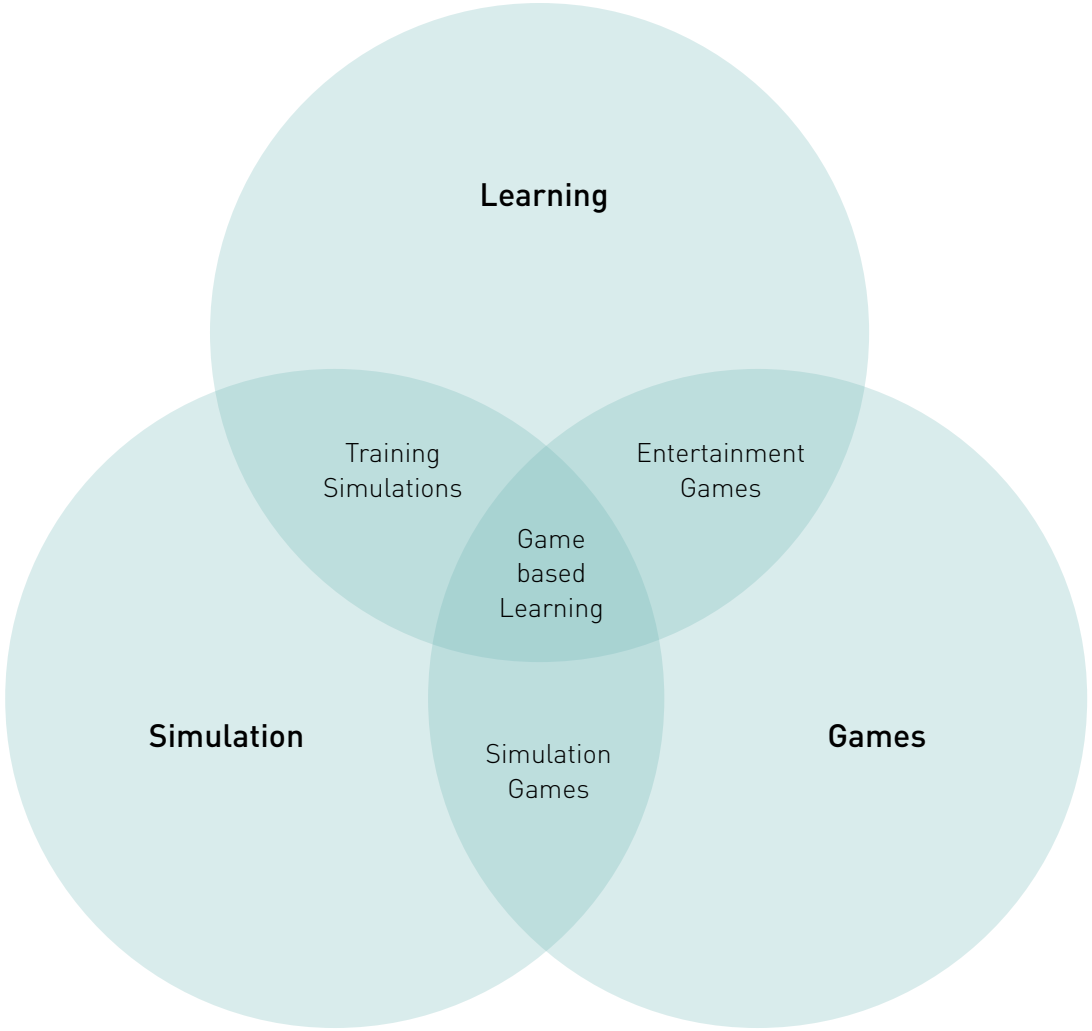



**Figure 2:**
Interplay of pedagogy, computer science and games (taken from Martens et al 2008, p.174)

Martens argues that without the inclusion of learning goals (pedagogy) the games are merely simulation games. If there is no simulation the results are edutainment games, often with a simplistic format. While omitting the game play and mechanics results in a training simulation.

Finally, Mike Zyda believes serious games can be distinguished from leisure games by the addition of pedagogy to the three main elements of computer games: story, art, and software (2005). However, unlike Martens et al. he also states the pedagogy, that which educates or instructs, must be subordinate, rather than equal, to the game play and story in his definition. Serious games rely on the relationship between these factors, the learning is dependent on the pedagogy and game.

This distinction between training simulations and serious games is echoed by the Serious Games Institute. They describe Triage Trainer (see Case Study 1) as a training simulation, despite the fact it can be won or lost (which can be viewed as a game mechanic) depending on the categorisation of patients.

Aldrich, Zyda and Martens believe that simulations are distinct from games, although differ as to whether distinct or a subsection. This relationship is expanded upon in the next section which focuses specifically on defining serious games.


Conspiracy Code: an immersive 3D game environment for teaching high school history. **www.flvs.net/areas/flvscourses/ConspiracyCode**

## Case Study 1: Triage Trainer, a healthcare training simulation

**Name:** Triage Trainer
**Type:** Training simulation
**Target audience:** Doctors, nurses, paramedics and other first responders
**Content:** Training to assess patients at an accident and emergency site
**Commissioned by:** ALSG
**Developed by:** TruSim
**Time to produce prototype:** 1 year

### Overview

Triage Trainer has been developed by TruSim, a division of Blitz Games, and is currently in its prototype phase. Triage Trainer is set at the scene of a high-street explosion, and is designed to train professionals who might be called upon at the scene of such an incident – doctors, nurses, paramedics and other first responders.

At the scene of a major incident, players must triage, that is, assess the degree of injuries using appropriate protocols and medical checks, of randomly generated casualties and prioritise them for treatment. The physical appearance of each casualty is driven by an underlying physiological model developed by medical experts. This accurately mimics the signs, symptoms and, crucially, the real-time deterioration patterns of injuries, meaning that a casualty's condition will change realistically over time. If patients are left too long without treatment, they will die. Players receive feedback on various elements of their performance, including the accuracy of their checks, whether they prioritised patients in the correct order, and the time it took them to complete, compared with that of an expert.

### Background

The concept for the game was based on a need identified by the charity Advanced Life Support Group (ALSG), who recognised that the typical methods for teaching triage (trainees are sent a manual, given a lecture and complete a table-top exercise) were not adequate in preparing trainees for the pressures of a real incident. In reality, such incidents happen very rarely, and their traumatic nature often leads doctors to make incorrect decisions; one common error is the tendency to try and stop and treat patients,

The concept for the game was based on a need identified by the charity Advanced Life Support Group (ALSG), who recognised that the typical methods for teaching triage were not adequate in preparing trainees for the pressures of a real incident.

rather than performing quick checks, prioritising and moving on. It was agreed that developing a near-real immersive game might be a cost-effective training method to minimise these risks. The highly lifelike quality of the scenario engages players in the game, puts them under pressure to perform well, and adds an emotional dimension to the experience, which is absent in paper-based methods. The project also aimed to contribute to the wider debate surrounding the effectiveness of serious games for training and retention in knowledge and behaviour.

The game's development was part funded by the Technology Strategy Board as part of an open grant (of £1 million over 4 years from 2006), and received additional support from co-partners, Selec Systems Integration (formerly VEGA Group), and Birmingham and Coventry Universities.

The game was trialled as part of a Major Incident Medical and Management Services (MIMMS) course run by the ALSG. All participants followed the same procedure: they received a manual on triage procedure and attended a lecture. Half the group then continued with the standard table-top triage exercise, and half played the Triage Trainer game. All participants then individually took part in a standard triage assessment exercise, where they attended to eight casualties at the scene of a barbecue explosion. Results showed that the game playing group showed statistically significantly better performance when applying triage tags.

**Evaluation**

Feedback from the participants involved in the trial suggested that Triage Trainer was successful in meeting its aims, and supported trainees to learn in a number of ways. Players associated their gaming experience with their real world experience, with many reporting that they felt they were "really there". Players were expected to make decisions under pressure, which supported their cognitive development. It was also found that players tended to discuss their experience with their course mates afterwards, which could also impact on their learning.

One element that has not been investigated by TruSim is the impact of the trials on knowledge retention and behaviour change. Unfortunately, exploring this element was not logistically feasible, but it is an issue they are keen to address in the future. ■

Players associated their gaming experience with their real world experience, with many reporting that they felt they were "really there".

# Defining serious games

Serious games as a term has been around for over 40 years. In 1968 Clark Abt called his book "Serious Games". It described his work in the 1960s in which he examined war-games (where dramatic scenarios were combined with mathematical analysis and the interplay of groups) and simulations to train managers, students, and teachers in educational-curriculum development, school-system planning, industrial management and technological planning and forecasting. His definition of such games was that they:

"have an explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement. This does not mean that serious games are not, or should not be, entertaining." (Abt 1970, p9).

However, since the creation of digital games there has been much discussion trying to separate serious games from leisure games. Why is a distinction needed? Prof Bartle argues that through this name it is acceptable to use them within formal education systems, and to have funding for their research[17]. An example of the first reason is the UK military. The military tolerate the term serious games, when they would not use the term games, although the preferred term is "low cost simulations based on commercial off-the-shelf technology"[18]. To illustrate the discussion below are a few of the definitions of serious games:

"Serious game: a mental contest, played with a computer in accordance with specific rules, that uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives" (Zyda, p.25)[19].

Serious Games are defined as digital games and equipment with an agenda of educational design and beyond entertainment (Sorensen & Meyer 2007, p.559).

**17.**
See Appendix D for notes from the interview with Prof Bartle.

**18.**
This was discussed with John Hoggard, a lecturer in Simulation Defence, see Appendix D for notes from the interview.

**19.**
This definition from Mike Zyda, creator of America's Army (one of the most influential serious games) is the one used by the Serious Games Institute.

"the label [serious games] refers to a broad swathe of video games produced, marketed, or used for purposes other than pure entertainment; these include, but are not limited to, educational computer games, edutainment and advertainment [...] and also health games and political games. [...] In theory, any video game can be perceived as a serious game depending on its actual use and the player's perception of the game experience." (Simon Egenfeldt-Nielsen et al. 2008, p.205).

Serious games aim "to use new gaming technologies for educational or training purposes. It investigates the educational, therapeutic and social impact of digital games built with or without learning outcomes in mind." (Felicia 2009, p.6).

"There is no one single definition of the term "serious games", although it is widely accepted that they are games "with a purpose". In other words, they move beyond entertainment per se to deliver engaging interactive media to support learning in its broadest sense." (Stone 2008, p.9).

"entries will be considered a serious game if they have gaming attributes, involve an assigned challenge, and employ some form of positive and/or negative reward system" (definition for entry to The Fifth Annual I/ITSEC Serious Games Showcase[20]).

From this short list it can be seen there is no agreement in definition. However, there is a consensus around serious games: having a learning objective (whether explicit or not), being an engaging interactive media, and having some game element. "Fun", is, or is not, a prerequisite of a serious game – although as found by Kirriemuir and McFarlane (2004) it is the most important reason given for playing leisure games. Also there is no agreement on how overt the learning should be. Is it necessary that the learner appreciates the educational goals or is it sufficient that the game has that purpose?



**20.**
For details of the definition and competition generally see **www.sgschallenge.com/index.html**

As well as no agreement in definition there is no agreement in what games can be classified as serious. Simon Egenfeldt-Nielsen and colleagues describe three categories of educational computer games: edutainment (eg Mathblaster!), commercial entertainment titles used for education (eg The Sims), and research-based educational games (eg Global Conflict: Palestine[21]) – which go beyond the edutainment titles as they no longer feed the player information but encourage curiosity and exploration (Simon Egenfeldt-Nielsen et al. 2008). However Ben Sawyer, co-director of the Serious Games Initiative[22] and co-founder of the Serious Games Conferences, and Peter Smith, University of Central Florida (2009) believe all games are serious and listed the following as terms that describe serious games:

- Educational Games
- Simulation
- Virtual Reality
- Alternative Purpose Games
- Edutainment
- Digital Game-Based Learning
- Immersive Learning
- Simulations
- Social Impact Games
- Persuasive Games
- Games for Change
- Games for Good
- Synthetic Learning Environments
- Game-Based "X"[23]

**21.**
The player takes the role of a journalist who has just arrived to Palestine. His task is to write an unbiased article about the unfolding events. Information is gathered by talking to a Palestinian imam, an Israeli soldier, a Palestinian mother of a martyr or an Israeli teenager. All are modelled on real characters. By talking to people from both sides of the conflict, the player gets different views and evaluations. The external goals are to teach the practice of journalism, media literacy, and research and how to write a history using only secondary sources..

**22.**
The Serious Games Initiative was founded in 2002 with the aim of ushering "in a new series of policy education, exploration, and management tools utilizing state of the art computer game designs, technologies, and development skills". From this came the Games for Health organisation which, through conferences and fostering relationships, brings together researchers, medical professionals, and game developers to share information about the impact games and game technologies can have on health care and policy.

**23.**
The X can stand for **learning** – as in Game-Based Learning, predominantly used when describing any game used in children's education, for example, role play or learning languages through singing games. Alternatively it can stand for **training** - as in Game-Based Training. This is often used describing games or simulations for adult education, this can be role play or storytelling.

Although appearing comprehensive and contradicting Aldrich's continuum, within the research community even this is not a definitive list of terms. Kebritchi and colleagues use the term instructional games for "computer games designed for training or educational purposes" (Kebritchi et al. 2010, p.427). While Simon Egenfeldt-Nielsen and his colleagues include advertainment or advergaming and political games as serious. Advertainment is used for marketing – these are usually casual games designed to get visitors to the website. They can be integral games – where the message is integrated into the game play – such as Toyota's Adrenaline racing game from 2000, or giveaways where the gameplay is separate to the product placement. For example, in Super Monkey Ball a player picked up bananas with the Dole brand[24]. Political games are designed to change viewpoint, such as Darfur is Dying (Egenfeldt-Nielsen et al. 2008).

To conclude, within the research community there is no fixed definition of a serious game. Although the majority view serious games as: having a learning model embedded, the content is integrated into the game so learning is intrinsic to play, and the assessment of learning may be integral to the game or occur through mediation around the game. These variations could cause confusion amongst educators, trainers and policy makers when trying to identify what digital game can be successfully used to achieve a learning goal. Given the variation in methods and definitions, for the purposes of this report the term serious games will be used to refer to digital games (including simulations and edutainment) with the intention of teaching specific predefined skills or knowledge.



24. **www2.sega.com/gamesite/supermonkeyball2/minigame/** - however, the current game has no banana branding.

# How do serious games engage with pedagogy?

All digital games, simulations and virtual worlds involve learning, even if only to determine what buttons to push, but when designing serious games there is a fine balance between learning what the game is designed to teach and learning the game. As Gunter and colleagues argue, placing educational content inside a game does not guarantee that it will succeed in achieving a fun, motivating experience; meet educational goals; or be a commercial success. They are also concerned that game designers feel that games are educationally sound as they require the player to recall rules, game mechanics and processes from previous levels. This ability to play, however, is not the same as mastering content (Gunter et al. 2008).

The previous section defined serious games as having an underlying pedagogy in order that virtual worlds are not confused with serious games. In this section, the history of serious games and the underlying models to achieve learning are examined.

There have been three generations of educational games defined by their underlying pedagogies (BinSubaih et al. 2009). The first is based heavily on behaviourism. Learning occurs through conditioning with the game element typically being a reward for the correct response to the stimuli. These games are often called edutainment. For example, in MathBlaster! the player's reward is to shoot balloons if getting a sum correct – the sum itself is separate from the reward. Another game based on behaviourism is the online DiDA delivered course supporting the DiDA qualification that has a module on game authoring[25] (see Figure 3). Brain training games would fall into this category. Edutainment games tend to be based on tests, formats can include:

– an objective test game
– a subjective test game
– a selective test game
– a drag-and-drop test game
– a memory-like game
– an arcade game

25.
For a description of the Edexcel programme of work see **http://www1.edexcel.org.uk/D205_0909/html/SPB205Index.htm**

This was followed by digital games based on cognitivsm. The learner became the centre of attention and acquires knowledge through a variety of different modalities (eg text, pictures, sounds). These enable the player to identify and analyse problems and apply past learning. Learning is the process of connecting symbols in a meaningful and memorable way (for example, exploring microworlds). Also in this second generation were games based on constructivism, that is, learning by making. The player is immersed in a world that enables them to include feelings and emotions with the social, the player can interact with fellow participants in the virtual environment as well as acquiring and using knowledge gained (for example military simulations to develop knowledge of convoy driving with colleagues).

In the third generation there are multiple models for learning. Constructivism became constructionism – where learning is reinforced by having to explain it. Others used the experiential learning theory, where one learns by doing (as well as seeing and hearing). Kolb's learning cycle relates to experiential learning as it consists of: concrete learning, reflective observation, abstract conceptualisation (forming a theory-based experience) and active experimentation – the decision and problem solving stage. This can be illustrated by games such as VentureSim (see Case Study 2) and Global Conflict: Palestine (see Figure 3). This experience-based learning is well-suited to games. Situated learning has been incorporated, that is, information used in context through a creation of a setting close to reality can easily be transferred to the real world. Simulations such as that used by the military often use this model[26]. Socio-cultural theory describes how games can be used as tools to mediate learning through discussion, reflection and analysis – with learning facilitated by the culture and identity of the learner. The final model mentioned by BinSubaih and colleagues is the full-learning cycle. Learning starts with an initial understanding, that knowledge is tested, and the feedback results in a refined model. This is the model used by the police service in Dubai (BinSubaih et al. 2009).

**Figure 3:** Screen shots illustrating edutainment (from DiDA delivered) and a game based on experiential learning (Global Conflicts: South America)

26.
See the description of games in the military section (p39) for examples of situated learning games.

## Case Study 2: VentureSim

**Name:** SimVenture
**Type:** Business simulation game
**Target audience:** 14-30 year olds
**Content:** The realities of setting up and running a business
**Cost to make:** £250,000
**Developed by:** Venture Simulations
**Time to produce:** 4 years

**Overview**
SimVenture is a business simulation game, designed for 14-30 year olds who are learning about the realities of setting up a business. It was developed by brothers Paul and Peter Harrington of Venture Simulations and since its launch in 2006 it has been widely used both in post-16 education and as a training tool in commercial organisations.

At the start of the game, players are given a brief and a background to their scenario. They are beginning to run their own business from home, making and selling computers, whilst holding down a separate full time job. The game takes players on a journey from running a small business in their own home, to running the business full time, relocating to larger premises, hiring staff and becoming a successful independent firm. Players are able to progress through the game by learning the important elements of entrepreneurism, arranged into four categories: organisation, finance, sales/marketing and operations. Players make decisions about activities within those areas, and observe the outcomes of their actions. For example, they might decide to carry out some market research in the area of their business, apply for a bank loan to help the business get going, or change the design of their product in response to customer feedback. Once they have made their decision, players "run" the month, and immediately see the effect their choices have made on their business.

Players get feedback on a number of different parameters. At a basic level, they can simply review how much income they're generating. As well as this, success can be measured by how many enquiries and orders they have received for their product. Furthermore, the game provides visual feedback to represent the efficiency of their organisation, and their happiness as an individual. All of these parameters vary according to the decisions that the player has made – if the player decides to carry out a large number of projects within a certain month with little outside help, their happiness rating may decrease, but they might make more profit.

## Background

SimVenture was developed as a response to Peter Harrington's frustrations in the area of business enterprise. In the late 1990s, government policy was beginning to reflect a new emphasis on the development of entrepreneurism and business skills, as a way to advance the UK's position in the competitive economic market. New policies were accompanied by significant funding for schools and colleges to support the improvement of such skills. Despite this, while working in the area, Peter recognised very few changes in the way business training was delivered, and identified a need for a more immersive, challenging and meaningful experience for learners. Consequently, Peter teamed up with his brother Paul, a software developer, and together they developed the SimVenture game. With a combined personal investment of £250,000, the game took four years to develop, with the first version ready for release in 2006.

## Evaluation

Phil Warren, Head of Business Studies at Snaith School, has used SimVenture to supplement the GCSE Business Studies syllabus. He says that the standard syllabus only requires students to learn about the various different elements of business in isolation (such as finance, marketing and operations). In reality, any decision that is made in one part of a business has a knock-on effect in others: the different components relate to each other in complex and subtle ways, yet students are not required to understand how these systems interact.

The school purchased SimVenture as a response to this frustration, and students typically play the game over a period of five weeks towards the end of their GCSE course, as a chance to apply their knowledge from the course into a practical activity, and consider business in a more holistic way. Phil reports that this has

been a highly successful strategy, with the vast majority of students becoming highly engaged in the game and achieving good results from starting their own virtual business. Playing SimVenture in a scaffolded environment, where a teacher provides support, guidance and time for reflection, appears to be the most effective way of ensuring learning takes place. Phil has also found that allowing students to play in pairs, rather than alone, is valuable because it allows room for discussion around decisions and students learn from their mistakes together.

Phil has reported that it is difficult to be sure whether the skills learnt in the game are transferable to real life because it is difficult to work out the direction of causality – whether students' entrepreneurial skills allowed them to succeed at the game, or whether the game improved their entrepreneurial skills. Thus far, Phil has not formally assessed students' learning gains from the use of SimVenture, but observes anecdotally that it has been a useful learning tool. ■

This has been a highly successful strategy, with the vast majority of students becoming highly engaged in the game and achieving good results from starting their own virtual business.

Third generation games blend the conditional (the rules, etiquette, software or learning goals) with the experiential (the sense of play, agency, learning, improvisation and feedback). Thus in these games you know, or can determine, the goal but have the ability to identify and enact your preferences, exercise your own choice, and make mistakes. Successful games are a combination of potentially adaptive structures (such as rules), and the timely delivery of information. Both of these are relevant when teaching. Hence the Institute of Education arguing that using game design theory can inform virtual world pedagogy such as that within Second Life, despite the fact it does not have game elements, such as levels and high scores, as part of standard interactions.

# How do games assess learning?

One of the major concerns identified about using digital games in education is the difficulty in assessing effectiveness at achieving the learning goals. How does a player of Civilisation, for example, demonstrate that they know the seven wonders of the ancient world rather than merely acquiring stars? As Jeffery Chin and colleagues' state: "Designing ways to collect data on student learning in simulation and gaming is particularly difficult because of the open-ended nature of these activities" (Chin et al. 2009).

How games assess an individual player is different from evaluating general effectiveness through control trials or focus groups. Teachers are expected to ensure their students achieve a certain mastery of facts or procedures. Regardless of what other tools are used. Also, teachers need to demonstrate that these skills, be they general skills such as problem solving, specific factual knowledge, such as that gained in playing Civilisation, or specific skills, such as those found in epistemic games or in Code of Everand (where the goal is to learn how to safely cross the road[27]), are transferable. Students need to recognise how to use the facts, procedures and processes learnt and practiced within the game outside of that arena.

Some pedagogies incorporate testing. There are explicit scoring mechanisms that can be used in edutainment; the number of correct answers, and possibly time taken to complete a game are measures. In simulations, although the choices can be complex, assessment can be a comparison of the outcome and the decisions made to reach that solution compared against the ideal. This also applies to epistemic games (Gee & Shaffer 2010), that is, games where the player has to recreate the answers of an expert. This is more complex in games where the skills being learnt are more abstract and have to be transferred to circumstances outside of the game. The appropriate pedagogy is dependent upon content and context. It influences, but is not the only factor, when assessing learning. The game play may have more of an impact on learning as that determines how feedback is given.

Civilization: players lead their chosen nation from the dawn of man through the space age. **www.civilization.com**

**27.**
Code of Everand is set in an expansive and varying virtual world. Players take on the role of Pathfinders, who are heroes of society because they are the only residents able to cross the spirit channels safely. Pathfinders carry out quests for other residents of Everand who cannot traverse the land so freely. Pathfinders can advance through a number of levels, can buy goods with the coins they have earned on quests, develop their skills in magic and alchemy, enter competitions and socialise with other players. The spirit channels are inhabited by dangerous creatures, and to cross them involves techniques used in the real world for crossing roads, eg stopping and looking both ways. See **http://codeofeverand.co.uk**

The idea that digital games are assessment tools has been made by James Gee and David Shaffer. They argue that games are good assessment engines, which is why they are good learning engines. However, they are assessing what the Epistemic Games Working Group term '21st century skills'. So rather than facts Gee and Shaffer focus on skills such as the ability to innovate, collaborate, think critically, produce digital media, perform system thinking (ie to recognise the relationship between elements) and enhance civic engagement. Measuring how well these skills are demonstrated is complex, multiple choice tests are an inappropriate measurement. Their conclusion is that there needs to be a rethink about what is assessed, a shift from the factual to the process.

There needs to be a rethink about what is assessed, a shift from the factual to the process.

Alternatively assessment could be informal, where the attitude and appreciation of others indicates achievement. James Gee would choose to assess effectiveness by how the students are perceived after playing games. He believes that games ought to encourage and equip students to become high-status members of Pro-Am (professional amateurs) groups. That is innovative, committed and networked amateurs working to professional standards in whatever they have developed a passion for **and** having their work recognised by their community (Gee 2008).

Returning to assessing skills defined by the current curriculum the idea of explicit testing is at odds with leisure game design. Some of these leisure games automatically adapt to the player's ability, gather data about their choices over time, provide feedback on these inputs, and provide relevant information as appropriate. In these games progress can be assessed through mechanisms such as high scores, leader boards, winning and losing a scenario, or completing a boss level. Although in formal education good work may be rewarded by a star, and is frequently assessed numerically, the idea of comparing scores and creating league tables of students is not commonly advocated. However, it is interesting to note that young people respond to such measures. In a first year primary school children spontaneously set up a league table around the number of correct steps they could perform on a dance mat (Williamson 2009, p.31).

The difficulty of assessment within educational games is acknowledged. Most existing assessment systems are bespoke to the game. For example, Valerie Shute has suggested models for embedding evidence-based assessment. Using the game Quest Atlantis Taiga Park Dr Shute proposes a method for requiring students to create causal diagrams electronically. Instead of teacher assessment the software can compare with expert diagrams and provide appropriate feedback and measure progress over time (Shute et al. In press). However, this kind of mechanistic testing is only appropriate for certain tasks. This is an issue currently being addressed by game developers. As Simon Egenfeldt-Nielsen discussed[28] this can either be through adding traditional assessment techniques, such as adding multiple choice questions after the game, or incorporating it into the game so that the facts have to be learnt in order to progress.

To conclude, if there is still the need for explicitly ensuring learning goals have been reached there needs to be some form of testing (either internal to the game or externally through mediation) to ensure players have learnt what is intended. This highlights the need for the teacher to make explicit what has been learnt and mediate the learning process. This is tricky, and requires understanding the learner and game and how to manage reflection. Jess Schell (in a talk to the Games Based Learning Conference 2010[29]) suggests that when using video games for learning (be they serious games or not), that it is the role of the teacher to put themselves forward and use the players experience to lead reflection. That the learning is stimulated by the game but occurs outside. This has been shown to be effective in military training. Games, as stated before, are advocated as part of a blended learning process, and therefore the role of the teacher is essential (Felicia 2009).

The role of the teacher is essential when using games in the classroom.

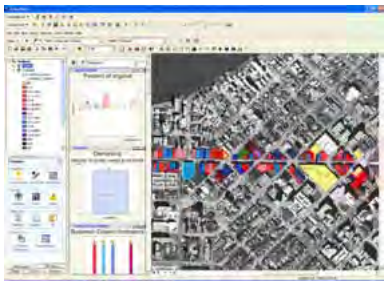
**28.**
See Appendix D

**29.**
See **www.gamebasedlearning.org.uk/component/option,com_smf/Itemid,58/topic,91.0**

# Summary



Despite the disagreement around terminology and definitions for the rest of this report serious games are used to define games with an embedded pedagogy, some form of internal or external assessment, and content to be learned (knowledge or procedural) integrated into game play. In the next section serious game use is considered in various domains to identify trends in use.



Urban Science: players can present their final plans as a three-dimensional model of the redesigned city.
**http://epistemicgames.org/eg/category/games/urban-planning**

# Serious games adoption in multiple domains

Serious games are being pioneered in several different sectors. This chapter looks at those sectors, the games used and developed for them, and some of the issues involved in using them.

Serious game usage, that is, using games to assist learning specific goals, is increasing, though more so in training and vocational areas compared with education (JISC 2007). Sara de Freitas (2006) believes this vocational focus is due to the experiential and problem-based learning approaches that are often the pedagogic models. Training and vocational areas involve learning how (procedures), rather than understanding how (a more abstract and higher level understanding). The latter is more commonly found in formal education - although both are learning.

One potential of serious games, regardless of domain, is that they can integrate into existing institutional systems and cognitive tools, for example discussion forums, bulletin boards and concept mapping software which is more widely used out of a formal education context. This community is already established and shown to be a valid learning and support tool in leisure games such as World of Warcraft[30]. In particular, the use of multiplayer online games promotes this 'tie-in' with other software tools. In some cases in the USA, games are being used as an interface to e-learning materials, resources and courses (JISC 2007).

This 'tie-in' is not the only reason for their use. Smith (2007) argues that there are five factors which have influenced serious game adoption in a number of environments that influence the degree and take up of game technologies:
– computer hardware costs
– game software power
– social acceptance
– other industry successes
– and native industry experimentation

This section describes how serious games are used in fields inside and outside of formal education. It considers both the reason, to develop vocational, or higher order understanding, and the practical reasons for game adoption in order to identify if there are themes around usage.

World of Warcraft: a massively multiplayer online game with diverse learning and support communication methods available to its community.
**www.worldofwarcraft.com**

**30.**
For a discussion on the communities that arose from massively multiplayer online games see The Warcraft Effect in Fun Inc (Chatfield 2010, pp.87-110).

# Military

Early games were often based around combat or fighting, for example, the board games Chaturanga and Wei Hei - both around 4000 years old - were war games designed to develop strategies for battles. The potential of digital games as training tools for the military has been recognised for over thirty years[31]. In 1981 a prototype simulator was commissioned by the US army for infantry vehicle training. The Bradley Trainer, originally called 'IFV' (Infantry Fighting Vehicle), used the controls from a real Bradley Fighting Vehicle and modified existing 'Battle Zone' hardware[32]. However, it was not until 1996 and the emergence of Marine Doom that the potential of games was appreciated. Marine Doom was a variation of the 1993 game Doom. Instead of a first person shooter dynamic set in a maze, realistic weaponry and carefully structured environments were introduced, and players' tasks included learning the proper sequence of attack, conserving ammunition, how to communicate effectively, take and give orders and work as a team. Games allowed this training to take place in an engaging method, but without the cost, inconvenience and time of running the training sessions in the real world. These simulations provide a means of allowing players to practise in situations which would otherwise be too costly or dangerous to be provided in real life and where mistakes could be catastrophic, and allow repetition until mastery is achieved.

Another illustration of the beneficial immersive experience was the Caspian Learning Rounds Inspection Simulation to train young officers who had been in training for fewer than 20 weeks about weapon checking (safety round) on ships[33]. This was a proof of concept project to see if knowledge was retained better than the current training lecture method. It was a high fidelity simulation following an epistemic model, the player got points according to their competency, and they could fail which resulted in the ship blowing up. Like games in the army, the navy felt that games were only appropriate in a blended learning environment.

ARMA 2: introduces players to team-based combat, a playbook of military tactics and a battlefield on which to practice tactical and strategic skills. **www.arma2.com**

**31.**
Note that this discussion focuses on games, rather than bespoke simulations for aircraft etc - although these are clearly effective in teaching pilots to react to specific situations that are too dangerous or expensive to practice in the real world.

**32.**
See **www.arcade-history.com/?n=bradley-trainer&page=detail&id=330** for details, this was recommended by John Hoggard.

**33.**
For a description of the simulation see **www.caspianlearning.co.uk/results/case-studies/maritime-warfare-school-uk-navy-rounds-inspection-simulation**

One reason for the popularity is the ability to modify (mod) the games. The UK army has a gold licence for Virtual BattleSpace 2. This is a fully interactive, three-dimensional training system which the army can adapt and customise. It can be used to represent real terrains and equipment so that it is suitable for a wide range of military (or similar) training and experimentation purposes[34]. This has led to applications for learning to drive convoys, kit out workshops, practice flying unmanned vehicles, and debrief and train soldiers for actual events[35]. For military purposes this gold licence is essential due to the need to keep secret the exact capabilities of tanks and scouting robots. The licence means that once the initial commissioning was complete, which initially took four years given the small company size, future adaptations were not problematic. The military still have a strong relationship and work closely with the original developers, for example, when new assets and models, such as calculating the impact of underslung loads in helicopters, is required. Their model of working is very much user-led, with the trainers stipulating requirements.

The importance of simulations for the army has been recognised within the UK government. In 2008 the Ministry of Defence produced a strategy for simulation including modelling and synthetic environments. This report justifies the use, and drawbacks, of simulations. Advantages include:

- Cost - both in operational hours and consumables
- Scheduling
- The ability to represent operations and battle spaces at medium or large scale without impacting on scarce manpower and platforms
- Potentially replicate the complex contemporary operating environment - incorporating Network Enabled Capability and including diplomatic, economic, asymmetric and other behaviour-based interactions
- Recording the tailored scenarios for review and re-enactment
- Allow exercises that could not happen otherwise for reasons of safety, security, geography, political sensitivity or increasing weapon and sensor capabilities

There are applications for learning to drive convoys, kit out workshops, practice flying unmanned vehicles and debrief and training soldiers for actual events.

**34.**
For a further description of the software see **www.bisimulations.com**. It is also discussed by John Hoggard, a lecturer at Cranfield specialising in defence simulation in Appendix D.

**35.**
For a more detailed discussion of usage see the expert interview with John Hoggard in Appendix D.

This report also acknowledged that there is:

– High initial and modification costs.

– An inability to fully replicate physical (eg radar performance), physiological (eg stress) and psychological effects (eg fear).

The UK military now aim to improve interoperability, sharing assets, tools, geo data, and scenarios between various projects as well as taking advantage of commercial off-the-shelf products (DAES 2008).

Games developed by the military are not only used by the military. The most commonly cited example of a serious game is America's Army. Using the criteria of usage it has over ten million players online; dollar for dollar it is the most effective recruitment method for the US army (Chatfield 2010). The popularity, as pointed out by Dr Dunwell, is the topic - it lends itself to an already popular gaming genre.

Finally, the US army are exploring the use of serious games as a way of treating post traumatic stress disorder[36]. This VR technology is also being investigated for stroke rehabilitation and to assess the cognitive abilities of adults with Alzheimer's disease and children across a range of clinical conditions which leads into the next section, serious games for health issues.

America's Army: a virtual web-based environment in which players experience soldier development from individual and collective training to deployment in simulated missions.
**www.americasarmy.com**

**36.**
See the work of Dr Rizzo, for example, **www.army.mil/-news/2010/04/19/37572-army-technology-comes-to-life-at-ict/** and more general research at **www.usc.edu/projects/rehab/advisors/rizzo/**

# Health

Serious games dealing with health issues are a growing field. The Games for Health annual conference, which describes itself as three days to explore the role of video games in health and healthcare, has been held for the last six years and is getting larger. In 2010 there were 45 presentations featuring: active gaming, rehab and physical therapy, disease management, health behaviour change, biofeedback, epidemiology, training, cognitive exercise, nutrition and health education[37]. The topics vary from looking at exer-gaming, for example, how to treat snowboarders' knee[38], to training procedural skills (Hoffman 2006). The range of games shows that there are bespoke games adapting existing kit, as well as commercial exercise games for the Wii fit. The kit need not only be on the Wii or PC, there is a trend for developing games using mobile technologies and other interfaces. For example, breathing into a microphone to control gameplay on an iPod Touch.

Health games for practitioners (doctors and nurses for example) tend to be simulation-based and used for training. For example, the Hollier Simulation Centre pilot in 2008 in Birmingham allowed junior doctors to experience and train for a variety of acute medical scenarios using computerised mannequins as patients. The learning occurs through the experience, and by reviewing the sessions - which can be replayed and analysed using high-tech digital recordings. This experiential learning was found useful and doctors wanted this type of training to happen more frequently. On the basis of this Hollier Simulation are hoping to build a regional training facility[39]. This belief that simulation games are effective teaching tools was corroborated by US research with trainee doctors (Kron et al. 2010).

Triage Trainer: supports development of life saving skills using protocols from Advanced Life Support Group.
**www.trusim.com/?page=Demonstrations**

**37.**
The full conference details can be found at **www.gamesforhealth.org/details.html**

**38.**
For a range of exer-games see **www.gamesforhealth.org/gfh-2010-sensorimotor-rehab-track-flyer.pdf**

**39.**
See **www.hollier-simulation-centre.co.uk/default.asp?page=330** for a brief overview of the pilot and the presentation to the Games Based Learning Conference 2010 by the surgeon Jonathan Stewart - **www.gamebasedlearning.org.uk/component/option,com_smf/Itemid,58/topic,87.msg160#msg160**

It is not only role-play that is useful for medical practitioners. In his dissertation Smith compared traditional teaching and training using virtual reality and game technology-based tools in laparoscopic surgery (that is, minimally invasive or keyhole surgery). He found the latter was less expensive, took less time, resulted in less medical errors when surgery is actually performed, and allowed multiple symptoms and repetition (Smith 2008).

Returning to the UK another example of developers of health simulation is TruSim, a division of Blitz Games Studios. They developed Triage Trainer (see Case Study 1) as well as games for ward staff around ward cleanliness and patient deterioration. These were described as games rather than simulations because of the element of risk.

Games for the public that are not exercise related have less fidelity than training simulations although simulate outcomes. An example would be Ian Bogost's game Fatworld[40], a game about obesity, nutrition and socioeconomics in the US, or the game to tackle childhood obesity being developed by the University of Warwick, NHS West Midlands and the Serious Games Institute[41].

Game technology-based tools were less expensive, took less time, and resulted in less medical errors when surgery is actually performed.


Fatworld: a video game about the politics of nutrition. It explores the relationships between obesity, nutrition, and socioeconomics in the contemporary U.S. **www.fatworld.org**

40. **www.persuasivegames.com/games/game.aspx?game=fatworld**

41. **http://seriousgamesinstitute.co.uk/research.aspx?section=14&item=223&category=52**

# Commerce and corporate games

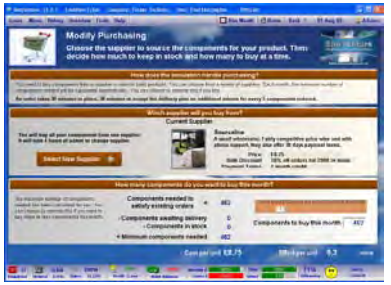
According to IBM[42] serious games will be used by between 100 and 135 of the Global Fortune 500 by 2012, with the United States, United Kingdom and Germany leading the way. Games in commerce have been used to recruit staff, improve communication between managers and their far-flung staff, and train employees at all levels (Derryberry 2007). In fact, IBM commissioned research to investigate the relationship between leaders in massively multiplayer online role-playing games (MMORPGs) with leaders in the real world. What was found was:

"the organizational and strategic challenges facing players who serve as game leaders are familiar ones: recruiting, assessing, motivating, rewarding, and retaining talented and culturally diverse team members; identifying and capitalizing on the organization's competitive advantage; analyzing multiple streams of constantly changing and often incomplete data in order to make quick decisions that have wide-ranging and sometimes long-lasting effects. But these management challenges are heightened in online games because an organisation must be built and sustained with a volunteer workforce in a fluid and digitally mediated environment (Reeves et al. 2008).

Interestingly, they also found that successful leadership was more dependent on the game structures than the individual leaders in that environment. They hypothesise if there were immediate nonmonetary incentives, for example points for commitment and performance, then leadership within the office is more likely to occur.

IBM itself not only uses games for internal training but has made part of its training programme a commercial product. Whether these games can be classified as serious, or advertainment - they require the use of IBM solutions to achieve answers, they are popular. Their game, INNOV8, has been downloaded by 1,000 schools worldwide and more than 100 universities worldwide have built custom curriculum using the serious game to help students learn about business process management. Their latest game to be published in the autumn of 2010, "CityOne: A smarter planet game", focuses on making energy, banking, water and retail systems more efficient.

Games have been used to recruit staff, improve communication between managers and their far-flung staff, and train employees at all levels.




SimVenture: allows players to setup and run their own virtual company and learn about business and being an entrepreneur. **www.simventure.co.uk**

42. **www-01.ibm.com/software/solutions/soa/innov8/cityone/index.html**

Commerce games are intended to be used as part of blended learning, so according to the CEO of Business Smart, Richard Berg[43] there should be a combination of games and simulations with face-to-face coaching and facilitation. However, as a game developer the key issue is identifying what the client wants and what can be achieved.

So why this focus on serious games in commerce? One explanation is the cost. With games there is a reduction in the need for training staff, training space, special equipment, and timetabling becomes easier. In his talk at the Games Conference Justin Bovey, the CEO of Rivers Run Red, described the advantages of virtual training in a bank scenario[44]. The trainee was exposed to various methods of learning: lectures, videos, role-play (in a virtual world making characters is not problematic), taking short online exams, and having a one-to-one assessment with a trainer. Although not a game in the traditional sense the environment used a game engine and various simulation techniques.

A second factor is realism, since using games can involve authentic content and authentic practice. As described by Beck and Wade games can incorporate the various streams of data available which has moved beyond traditional spreadsheets and linear models. Moreover, the number of employees who are familiar with video games is increasing, and compared to non-gamers, gamers have a deep understanding of risk versus reward and they are more able to take measured risks (cited in Michael & Chen 2006).

Finally, because of the authentic content, games can be used to develop business plans. Ben Sawyer describes a scenario where a company develops strategies for the real world through a virtual one, rather than modelling probabilities based on decisions (Sawyer 2009).

The Small Business Game: an online interactive simulation that gives your students the experience of running their own sports shop. **www.sport4life.biz**

**43.**
This is taken from a presentation to the 2010 Games Based Learning conference - see **www.gamebasedlearning.org.uk/component/option,com_smf/Itemid,58/topic,89.0**

**44.**
This is taken from a presentation to the 2010 Games Based Learning conference - see **www.gamebasedlearning.org.uk/component/option,com_smf/Itemid,58/topic,89.0**

# Informal learning

Games are often commissioned by groups who want to teach or raise awareness of something in parallel or outside of the formal educational curriculum. Games are seen as appropriate because of their "non-preachy" nature and the motivation young people have in playing with them. They are also seen as appropriate for a wide range of topics, from an awareness of poverty in the third world to gang culture in the UK.

The process of commissioning informal games varies. A need may be recognised by an organisation and tendered out to game developers, for example, the Parliamentary Education Service (PES) commissioning MP for a Week. Alternatively there are competitions where an organisation wishing to promote an understanding of their remit offers prizes for appropriate games. One example of this is the US initiative 'Apps for Healthy Kids'. This offered software developers, game designers, students, and other innovators prizes of up to $60,000 to develop fun and engaging software tools and games that encourage children to eat more healthily and be more physically active[45]. In contrast, other competitions focus on very specific areas, for example, around dating violence[46]. Alternatively, it can sometimes be more serendipitous, responding to calls from organisations that need to get a message across but are unsure of their format, which is how the Department for the Environment commissioned their game around climate change for the classroom (Operation: Climate Control[47]). Or there is the approach taken by Channel 4, which views games as an appropriate method of fulfilling its learning remit for secondary school students. However, in 2008 a meeting of the Alliance for Digital Inclusion[48] found that the government had no co-ordinated approach to using games for public policy purposes, despite commissioning them through various schemes[49].

**45.**
See **www.appsforhealthykids.com**

**46.**
The Jennifer Ann Group in the US sponsors an annual competition with a $2,500 prize for the best game raising awareness of the dangers of teen dating violence. See **http://jenniferann.org/2010-games.htm** for this years prize winners.

**47.**
See for an overview of the climate control games created by Red Redemption - **www.operationclimatecontrol.co.uk/content/press/press-info**

**48.**
From notes taken by Dr Ben Williamson taken at the ADI 2008 meeting "Can the Games Be Serious?" in Guildhall, London, on the 5 June.

**49.**
For example, games developed by the Parliamentary Education Group (MP for a week), the Department of Transport (Code of Everand).

Unlike in the military, health, and commerce domains many games in the public domain are not assessed to ensure the learning goal has been met in individuals, though like commercial games, the number of players is often used as indicator of success. Instead the game is evaluated for learning gains after release (although it has been designed with these in mind). For example, in the MP for a Week game there is no explicit external assessment of knowledge gained from playing, although there is support for teachers around how best to use the game. The evaluation of actual impact and learning so far has consisted of: a combination of statistics around the number of users and time played, and detailed user testing sessions in two different schools to provide qualitative feedback. However, the latter approach is time consuming and expensive, so some data between the two extremes would be useful. The PES did consider commissioning an impact study, but since it is still building its audience, this option would not have been cost effective. For Operation: Climate Control there was a small survey around effectiveness but it was restricted by a small budget that only covered the game design and production, while in the Climate Challenge game its effectiveness was evaluated as part of an MSc (see Case Study 3). In contrast Code of Everand is being evaluated by researchers' independent to the game developers[50].

MP for a Week: players experience the personal and professional dilemmas of a week in politics, taking responsibility for their decisions, and then seeing the implications on their careers. **www.parliament.uk/education/online-resources/games/mp-for-a-week**

**50.**
The Serious Games Institute and Futurelab have been commissioned to evaluate whether it impacts the behaviour children exhibit when crossing the road.

## Case Study 3: Climate Challenge game

**Name:** Climate Challenge
**Type:** Mini online sandbox strategy game
**Target audience:** Young professionals aged 20-35
**Content:** Communicating the consequences of climate change
**Commissioned by:** BBC, UK
**Developed by:** Red Redemption, UK
**Time to produce prototype:** 1 year

### Overview

Climate Challenge is an online sandbox-style strategy game developed by Red Redemption. It was released in 2007 with the aim of engaging young professionals aged 20-35 in the realities of climate change and measures that can be taken to decrease carbon dioxide emissions. It was supported and distributed by the BBC on their Science and Nature website.


In the game, the player takes the role of the leader of the European Nations from the year 2000 to 2100. The game consists of ten turns, each lasting a decade, and players must balance the need to lower carbon dioxide emissions with their responsibility to maintain vital resources.

In the first phase of each turn, the player is shown various options for policies which they can choose to implement. The policies are displayed as cards, organised under five categories: national, trade, industry, local and household. Each card shows a policy option, and depicts visual representations of its impact on budget, $CO_2$ emissions, and resources. A crowd of people on the right represent public opinion, and a swingometer depicts their level of approval for each policy. Once players have implemented their decisions, they receive immediate feedback, firstly by a simple graphic which shows how many clouds of $CO_2$ have been released into the atmosphere as a result of the new policies. Players then see an excerpt from "The Climate Times", a fictional newspaper which shows a news story and an opinion poll reflecting public opinion of the new policies and leadership. The next phase of each turn consists of negotiations with other world leaders, who must agree to set targets for the reduction of $CO_2$ emissions.

Climate Challenge: players can vote to regulate $CO_2$ emissions across Europe. **www.bbc.co.uk/sn/hottopics/climatechange/climate_challenge**

## Background

The idea for the game originated from an informal conversation between Gobion Rowlands, one of the founders of Red Redemption, and Myles Allen, an eminent scientist for the Intergovernmental Panel on Climate Change (IPCC). Myles had generated vast amounts of data from his modelling project climateprediction.net, and whilst this data was very dry, Myles realised that it ought to be put to good use by communicating important messages to the public about the likely consequences of climate change. He suggested that an effective medium for this could be a game, and Gobion agreed. At the time Myles was creating a television series with BBC Science and Nature exploring the outputs of his project, and he put Gobion in touch with the relevant contacts. The BBC agreed to fund the project, and the Climate Challenge game was born.

The game itself took five months to build, after the initial planning stage, and involved around 10-15 developers at any one time. Its main aims were to empower individuals by allowing players to explore the likely trajectory of climate change, and the effect human actions can have on carbon dioxide emissions. It was also designed to help young people explore different policy options, from local to global initiatives. Finally, the game aimed to communicate facts about climate change, by basing its figures and predictions on real scientific data, provided by the IPCC.

One of the reasons that the creators of Climate Challenge believe it has succeeded in meeting its aims is that it struck a balance between fun and accuracy. Scientific expertise was provided by an in-house expert, Hannah Rowlands, who contributed her knowledge at every step of the way. But Hannah also fully endorses the view that a game must be fun, and this remained a priority within the game design team throughout the project.

## Evaluation

Though the BBC's budget for the Climate Challenge game did not stretch to an assessment of the game's effectiveness in meeting its aims, Hannah Rowlands was at the time completing her Masters in Environmental Science, and carried out an in-depth research project on the game's effectiveness as a communication tool for her dissertation. Her results showed that many players did learn about climate change through playing the game, and there was some evidence of attitude change as a result of playing. It was also reported that the use of games as a communication tool, particularly for issues such as climate change, was supported by the participants in the study.

Its aims were to empower individuals by allowing players to explore the likely trajectory of climate change, and the effect human actions can have on carbon dioxide emissions.

Climate Challenge: players can vote to regulate CO2 emissions across Europe. **www.bbc.co.uk/sn/hottopics/climatechange/climate_challenge**

# Serious games and NEETs*

The adoption of serious games into education could address the wider issue of NEETs, that is, young people who are not in education, employment or training. It is estimated that 10% of those eligible for post-16 education could be considered a NEET, and this figure has remained stable for the past decade. The high number of NEETs in the UK is thought to be in part due to the decline in the manufacturing industries which in turn has caused a significant decrease in the number of unskilled and semi skilled employment opportunities. As such, young people who struggle to engage with more traditional academic routes into employment are not catered for in the current training and job market, and no longer have so many opportunities to socialise into adulthood.

Many educational reforms have been implemented in recent years to reduce the number of NEETs, since the unemployment of this group costs the economy more than £90m every week (McNally & Telhaj 2007). Those who are working to encourage engagement in this cohort of young people are increasingly recognising that digital media will likely be a powerful tool in reaching young people and supporting them to learn and develop vital skills for life and work. Since assumptions should not be made about young people's access to and use of digital media, there will not be one single solution to the problem. However, the use of games within this cohort (either on consoles, on the internet or on mobile phones) is almost ubiquitous. A large-scale US survey reported that 83% of teens have at least one console in their home (Nielsen Report 2009), and a similar survey in the UK suggested that 97% of 11-15 year olds and 82% of 16-24 year olds would describe themselves as "gamers" (Pratchett 2005).

Games would therefore appear to be a natural channel for reaching disengaged teens. Games could be used in a number of ways to contribute to different areas of the problem, including motivating and engaging those who are in danger of dropping out of formal compulsory education, reengaging and reaching those who are disengaged, and smoothing transitions from compulsory to post-16 engagement. It is this latter area in particular in which serious games could be harnessed, to support young people's transition into the world of work.

Games would appear to be a natural channel for reaching disengaged teens.

* This section uses information taken from a paper by Karl Royle. The paper was commissioned by Becta to explore the use of games in learning. Specifically, it looks at how games based learning (GBL) can be applied to 14 to 19 learning, with a particular emphasis on those classified as NEET (Royle 2010).

It has been suggested that serious games could assist in training young people's vocational skills in a variety of sectors, from business and entrepreneurship to manual jobs such as plumbing[52]. There are several serious games already on the market that aim to support players to develop both the functional skills related to particular vocations, and the "soft skills" which are required for young people to prosper in the world of work, such as problem-solving, communication, innovation and collaboration. One example of such a game is The Small Business Game[52], in which players are supported as they run a small retail outlet.

In the case of NEETs, serious games could provide a useful medium with which to introduce young people to the range of vocations in a non-threatening, risk-free and hopefully fun environment. In playing serious games, young people can have a go at working in a number of different fields, and can practice and hone their skills again and again in an environment where making mistakes does not equal failure. Indeed, within a game, mistakes are an intrinsic part of the mechanics, in that a player only learns how to proceed through a level by trying different strategies and selecting the most successful.

Furthermore, the "just-in-time" feedback that games provide could go some way to allowing disengaged young people to recognise their own personal progress, which in itself is a motivating factor to continue playing the game.

At this stage, no research has been conducted to investigate whether serious games could represent an effective intervention to engage and support young people not in education, employment or training to continue their learning. However, drawing from the literature about games and disengaged young people, it is possible to see potential in exploring this avenue further.

The Small Business Game: targeted at 14-18 year olds, players experience the start-up and management of a business, learning both from their mistakes and from their successes. **www.sport4life.biz**

**51.**
Games manufacturers, such as skills2learn **www.skills2learn.com**) currently provide a range of simulations used in colleges to introduce as well as provide continuing professional development in a variety of sectors, for example, plumbing, midwifery and call centres.

**52.**
See **www.sport4life.biz**

# Formal education[53]

The limited use of serious games in formal education may be related to the issues around using leisure games. That is, concerns about physical and cost barriers, having enough hardware, licences, sufficient access, IT support, and confidence in using the game, which includes having had time to read the manual, understand how the game relates to the curriculum goals, and an understanding of how learning will be assessed (Sandford et al)[54].

Moreover, games are not an effective teaching tool for all students. This is partly to do with the pedagogy. Failure is the norm in games, repetition and exploration is how players learn. This contrasts with learning discrete chunks of information which can be found in schools (Squire 2005). Squire found roughly 25% of students in school situations withdrew from his study, which used Civilization to teach geography and history, as they found it too hard, complicated and uninteresting. (To become a competent player takes six to seven hours, and to go through all the stages a hundred hours.) While another 25% of the students (particularly academic underachievers) loved playing the game, they thought it was a "perfect" way to learn history.

Furthermore the formal education system has to adhere to knowledge and procedures required for external exams. Thus games need to address these areas. Games that align to the curriculum appear to have a wider take up than those that are pedagogically sound and engaging but have no clear relationship. For example, Dimension M[55], a set of games modelled on a first person shooter where game progress is determined by correctly answering mathematical questions to score points is popular in the US. This game aligns to state standards for teaching and can track and report on student progress. Games which develop more critical skills that are harder to analyse and assess, such as Global Conflicts: Palestine, have a lower take up, which the developer attributes to the difficulty in integrating it into lessons given the time needed for the teacher to learn and the time it takes to play. This contrasts with leisure games, where time constraints are not usually an issue.

Games that align to the curriculum appear to have a wider take up than those that are pedagogically sound and engaging but have no clear relationship.

**53.**
The potential and rationale for using games in formal education has been discussed in the 2009 Futurelab paper "Computer games, schools, and young people: A report for educators on using games for learning. **www.futurelab.org.uk/resources/documents/project_reports/becta/Games_and_Learning_educators_report.pdf**

**54.**
An elaboration of this argument can be found in the interview with Simon Egenfeldt-Nielsen in Appendix D.

**55.**
See **www.dimensionu.com/math**

These restrictions have lead to games initially intended for teaching, such as Muzzy Lanes Making History game[56], becoming a leisure game for adults. The education aspect has not been lost, for example, they provide lesson plans[57], but the majority of their audience create their own scenarios for fun. Games such as SimVenture (see Case Study 2) solve this dilemma by supporting entrepreneurs aged 16-30 so can be used informally. They also have the advantage they can consolidate topics covered by the curriculum.

Schemes to encourage students to create serious games are being developed. One of the largest is the DiDA qualification that has a module on game authoring[58]. In turn this can be supported by DiDA delivered by the North West Grid for Learning. In addition to a textual description of the learning objects it incorporates what the authors describe as 300 serious games, although these appear to be short casual behaviourist games.

Serious games have a potential for well-defined fields, such as science, technology, engineering and mathematic (STEM) subjects. This is the focus for the US Games for Learning Institute. Simulations, as for military and health domains, allow the player to repeat till mastery in a safe environment that would be too costly, dangerous or time consuming to do in real life. Moreover, the possible fidelity may enhance transfer, as in the epistemic games where players are encouraged to use the terminology and approaches employed by professionals (Gee & Shaffer 2010).

Making History: players take full control of any world nation, colonies, regions, cities, and military units during the time leading up to and during the Second World War. **http://making-history.com**

**56.**
See **http://making-history.com**

**57.**
For example, they describe multiple ways of using their game, either as a single lesson, for groups and individual in **www.muzzylane.com/images/downloads/Instructors_Guide_Calm_and_Storm.pdf**

**58.**
For a description of the Edexcel programme of work see **http://www1.edexcel.org.uk/D205_0909/html/SPB205Index.htm**

# Discussion

From a review of existing games outside of formal education serious games, particularly simulations or tasks which require habituation, that is using knowledge acquired without conscious effort, are frequently used in domains such as the military and health. These games tend to have a high degree of fidelity in all aspects of the game. In informal learning games the fidelity is not high in some areas in order to increase focus on the relevant points, for example, not having to wait to see the outcome of actions in the Climate Challenge game.

Assessment in military and vocational health simulations tends to be a comparison with expert responses in simulation, or trainer-led through debriefing. Feedback mechanisms within the game tend to model results of actions, for example, what happens if too much is consumed, or blowing up the boat if a poor decision is made when doing the rounds. Transfer tends to be measured by reviewing performance in the real world rather than assuming that it naturally occurs from the game.

Other domains, such as those for NEETS, suggest games are more likely to be used if specifically commissioned, rather than created to address what the provider identifies as a possible need. Furthermore the ability to easily modify games in an educational field would be useful, for example, in order to customise tasks to the specific geographic location.

The 'tie-in' with other platforms is not yet prevalent. Although the areas identified by Smith, particularly cost, and the success in other industries plays an important role in the take up of digital games as learning tools.

Making History: players manage region and city-level projects, choosing technologies to research, directing military movement and development, conducting international diplomacy, maintaining domestic stability and producing vital resources. **http://making-history.com**

# The challenges in embedding serious games into formal education



There are many challenges in using serious games in formal education. This chapter looks at how these challenges can be approached through the use of three frameworks, which may help educators identify the issues, most appropriate games and benefits of their use.

Ian Bogost summarises the limitations and potential of games as educational tools:

"Games are hard to make. Good games are complex. The real promise of games as educational and political tools is in their ability to demonstrate the complexity and interconnectedness of issues. Games, like all media, can't ever really change behavior; a game about nutrition won't magically turn a player healthy, just as a game about criminality won't magically turn a player delinquent.

Instead, games can help us shape and explore our values. And today, our values better damned well be complex. They ought to be well informed and nuanced. They ought not to be black and white. They ought not to be bite-sized. They ought to take many factors into account."[59]

The real promise of games as educational and political tools is in their ability to demonstrate the complexity and interconnectedness of issues.

Taking this as a starting point the first challenge is to identify if a game exists that addresses the identified learning goals. As Sawyer pointed out in the debate "What's wrong with Serious Games?" there are games, it is just very few of their potential users are aware of them (Terdiman 2006).

In addition to the selection challenge Simon Egenfeldt-Nielsen adds another criterion. He states the most important consideration from a teacher's perspective is how much the game will make their life easier[60]. Thus the second challenge is to identify whether the selected game will easily enhance teaching, or, if there is not yet a relevant game in that area, what a game would need in order for it to be useful. This consideration involves more than just assuming games will motivate and engage learners, as Squires points out games in a classroom are not necessarily motivating (2005) but includes assessing whether alternative methods of teaching would be better. This stage also includes how does, or will, the game assess the required learning (BinSubaih et al. 2009).

**59.**
See the blog article dated March 18th, 2010 "Playing Political Games On the White House and Videogames" at **www.bogost.com/blog/playing_political_games.shtml** (accessed 1/6/2010).

**60.**
See the interview highlights in Appendix D.

In order to overcome this issue and support serious game developers and teachers to develop and select games, researchers have tried to identify the issues faced these tasks. For example the Games for Learning Institute (GFLI) have recently created a rubric for educators, researchers and designers. The rubric is designed to help all three groups evaluate educational games in 17 different design areas on a 5-point scale against three criteria[61]:

– **Technical implementation**: The activity of programming and executing a design pattern into a working version of the game. Includes the seamless integration of design elements within game play.

– **Educational appropriateness**: The ability of the game to address educational/curricular goals and the player(s) knowledge/ability relative to the educational content being addressed.

– **Overall integration with goals**: The integration of the design pattern being considered with the other elements within the game, and within overall game play and educational goals.

This is in addition to the criteria for choosing leisure games for teaching, eg the Teaching with Games project and the European project in digital games[62].

In the remainder of this section three approaches are examined to illustrate the methods that could be used by those considering and selecting games as a teaching tool: RETAIN, the four-dimensional framework, and balancing game and pedagogy. It is assumed these games will be developed or used as part of a blended learning approach, that is, they will be one of multiple methods of teaching. The section concludes with a synthesis of the key areas that need to be considered when selecting a serious game.


Quest Atlantis: players can work as a Field Investigator for a Park Ranger to collect evidence about a growing catastrophe, interviewing different characters in the park and finding out their perspectives on the problem. **http://worked_examples.crlt.indiana.edu/projects/5**

**61.**
The presentation was given on the 12th July at the Games Based Learning Conference in Wisconsin. As yet no information around the 17 design patterns has been published although they will be used to evaluate the games in their own Game Design Challenge **www.glsconference.org/2010/program/event/89**

**62.**
For an example of the list of criteria recommended for selecting games for classroom use see Appendix A. This list covering technical specifications, context and pedagogical considerations is the result of the European project into digital game use (Felicia 2009).

# RETAIN model

The Relevance, Embedding, Transfer, Adaption, Immersion and Naturalisation (RETAIN) Model was developed to:

1) support game development, and
2) in the rubric developed, assess how well educational games contain and incorporate academic content.

This model is based on three existing theories: Keller's Attention, Relevance, Confidence/Challenge, and Satisfaction/Success (ARCS) model and Gagne's Events of Instruction that are applied against a backdrop of Bloom's hierarchical structure for knowledge acquisition, and Piaget's ideas on schema (Gunter et al. 2008). Briefly, the five areas the designer or teacher/trainer needs to consider once the learning goals have been defined are given in Table 1.

Table 1 starts on the next page

The RETAIN model was developed to support game development and assess how well educational contain academic content.

Second Life: the internet's largest user-created, 3D virtual world community. **http://secondlife.com**

**Table 1: Required aspects for appropriate serious games**

| | |
|---|---|
| **Relevance** | i) presenting materials in a way relevant to learners, their needs, and their learning styles, and<br>ii) ensuring the instructional units are relevant to one another so that the elements link together and build upon previous work |
| **Embedding** | assessing how closely the academic content is coupled with the fantasy/story content where fantasy refers to the narrative structure, storylines, player experience, dramatic structure, fictive elements, etc |
| **Transfer** | how the player can use previous knowledge in other areas |
| **Adaption** | a change in behaviour as a consequence of transfer |
| **Immersion** | the player intellectually investing in the context of the game |
| **Naturalisation** | the development of habitual and spontaneous use of information derived within the game |

Each of these aspects can be divided into four levels: 0, 1, 2 and 3. Level 0 means the game design does not meet that aspect, while Level 3 indicates there is a strong correlation between the game and that necessary aspect. For example, in naturalisation if there is little opportunity to use the information already presented again it would be classified as Level 0; if it does require the player to use the information and encourage them to process it more quickly then it is at Level 1 - by Level 3 the player can assimilate information from multiple sources and spontaneously and habitually use it.

The final aspect of the rubric is the weighting of each aspect. Gunter and colleagues have ordered the aspects by importance. From least to most important, they are: Relevance, Immersion, Embedding, Adaption, Transfer and Naturalisation. Thus if a game fulfils Level 1 of transfer it is worth five points (1*5), Level 2 ten points (2*5) etc. Since relevance is seen as a less essential aspect of serious game design, this would mean if a game fulfilled Level 1 requirements would be worth one point (1*1), Level 2 two points (2*1) and so on.

Each serious game or game design could be assessed using this framework, and if the game fulfils Level 3 at every aspect it would be awarded a maximum of 63 points. Based on these scores the most appropriate game would be selected for use, or constructed.

Game aspects are assessed individually to identify the most appropriate game.

# Four-dimensional framework to assist evaluating the potential of games- and simulation-based learning

In 2004 Sara de Freitas and Martin Oliver proposed a set of four interrelated elements that could be used by:

1) educators to select appropriate simulations and games as teaching tools
2) researchers to assess serious games, and
3) educational designers to consider educationally specific factors.

In her presentation to the Serious Games Conference 2010[63] Dr De Freitas explained how the four dimensional framework was successfully working as a design tool as well as the original intention of an assessment tool.

Their argument was:

"Although a number of frameworks exist that are intended to guide and support the evaluation of educational software, few have been designed that consider explicitly the use of games or simulations in education. Similarly, research in game studies has generally focused upon approaches based upon playing leisure games, and therefore do not take enough account of factors including the context, learning theory and practice and the attributes of the learner and learner group." (de Freitas & Oliver 2006, p.262)

Thus this structured analysis is designed to support the processes to select the right content and software, and secondly find the best way to apply the tool within the learning context.

Although a number of frameworks exist that are intended to guide and support the evaluation of educational software, few have been designed that consider explicitly the use of games or simulations in education.



**63.**
See **www.gamebasedlearning.org.uk/component/option,com_smf/Itemid,58/topic,89.0** for the video (accessed 10th June 2010).

For each aspect they give a set of checklist questions to be addressed iteratively[64]. These questions can be broad, from "What is the context?", through to specific, "What level of fidelity needs to be used to support learning activities and outcomes?"[65]. The user may change responses in accordance with later answers.

What level of fidelity needs to be used to support learning activities and outcomes?

Briefly the four dimensions (also shown in Figure 4) are:

- **Context** which covers where the learning occurs - it includes the macro level, so historical, political and economic factors (for example, are you playing because it is a school directive), through to micro, the tutor's background and experience, cost of game licences etc.

- **Learner specification**, for the individual or group, requires the tutor to consider their preferred learning style and previous knowledge and what methods would best support them given their differing needs.

- **Mode of representation**, this includes the level of interactivity required, the fidelity, level of immersion produced. It also covers diegesis, the separation of the immersion aspect with the reflection around the process of playing the game. Most importantly it highlights the potential of briefing and debriefing to reinforce the learning outcomes.

- **Pedagogic principles** requires the tutor to reflect on the learning models (see the section 'How do serious games, simulations and virtual worlds engage with pedagogy?') which enables them to produce appropriate lesson plans.

These aspects cannot be considered individually, all are related (as shown in Figure 4).

Finally, de Freitas and Oliver believe the current structure of the questions mean they are suited for those in educational advisory roles, or educational software designers. The questions may need refining if to be used directly by a teacher (de Freitas & Oliver 2006, p.262).

**64.** The full list can be found in Appendix B.

**65.** For a full discussion of fidelity see Appendix C.

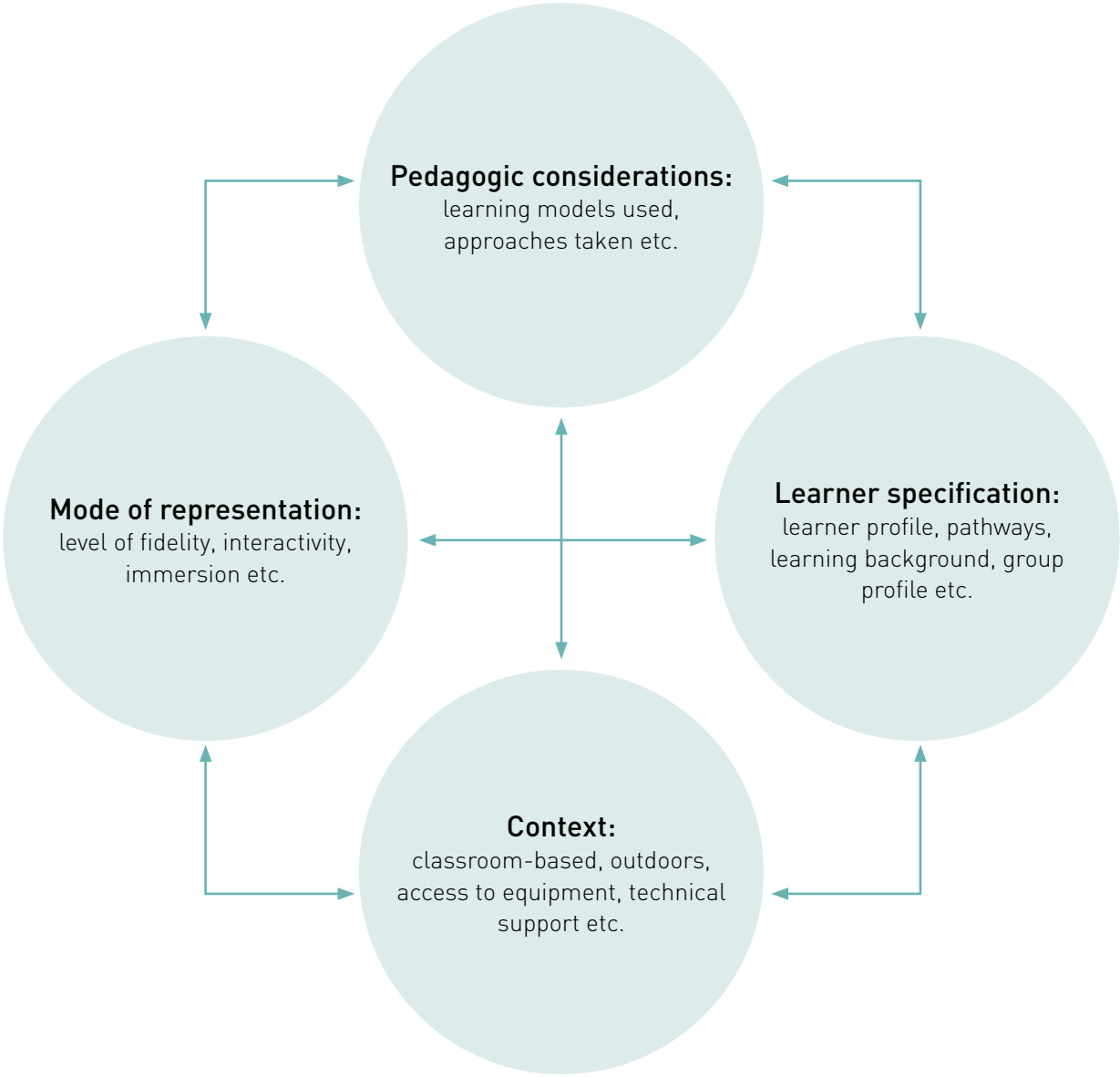



**Figure 4:**
de Freitas and Oliver's framework for learning considerations (2006, p.253)

# Balancing pedagogy, game and reality components

Harteveld and colleagues created the game Levee Patroller for the Dutch water boards. It was to support the recognition of flaws in levees, the artificial and real barriers that stop the inhabitants and goods of those in the Netherlands being washed away (Harteveld et al. 2007). Their goal was not only to develop the game but to guide future developers in making entertaining and educational serious games.

They theorise that a player should understand that a game has specific learning goals in order to appreciate the results. However, without this explicit framing, which may detract from the play element (games are usually played voluntarily with player control), there could be less learning as the player focuses on the goals and rules of the game[66]. Thus there is a fine balance when designing or using games with an educational focus. Their approach was to divide serious games into three areas for consideration, see Table 2.

| Area | Pedagogy | Game elements | Reality |
|---|---|---|---|
| **Attributes** | Attributes | Harmony | Learning objectives |
| | Experience | Uncertainty | Target group |
| | Low resource demanding | Interactivity | Challenge |
| | Exploration | Engaging | Clients |
| | Incremental | Flow | Organisation |

**Table 2:**
Attributes of a serious game

66.
For a further discussion on this aspect see (Simon Egenfeldt-Nielsen et al. 2008, p.217).

In **pedagogy** (learning) they advocate the need for reflection - which can be stimulated by an instructor, but is better if included in the game. There should be learning-by-doing, so learners should *experience* the learning - rather than being given windows of text. The third area is giving sufficient information but not too much to distract the learner or create cognitive overload. They term this *low resource demanding*. The learner needs to be active while playing, and encourage exploration rather than constantly directing. Finally from a pedagogical perspective the learning should be incremental, that is, they should acquire knowledge and integrate it into existing structures.

They also want the trainer to have the ability to configure the game in addition to the computer randomly selecting, in this case the weather and faults. They also advocate training levels, which are useful for the non-gamer.

In the second area they look at **game** (fun) structure. Game worlds need to be coherent and consistent, that is be *harmonious*. This could involve a degree of fidelity but is not essential. Creating such an environment is tricky as reality is not coherent. There needs to be an element of *uncertainty*, randomness makes a game challenging and enhances enjoyment. Games should be *interactive* and the decisions made impact the outcome. They should be *engaging*, so there needs to be rewards for actions (this feedback need not necessarily be points, though these are engaging) and keep the attention of the player. Finally there is *flow*; games need certain tasks that can be frustrating but obtainable.

There needs to be an element of uncertainty, randomness makes a game challenging and enhances enjoyment.


Operation: Climate Control: a multi-player computer game where the player's role is to decide on local environmental policy for Europe for the entire 21st century.
**www.operationclimatecontrol.co.uk**

Finally there is an element of **reality** (validity). This is context specific, unlike the other two which are more generic. Here they are concerned with accurately defining the *learning objectives* that need to be understood by the player. Considering the ability of the *target group*, for example, are they experienced video game players? That the *challenge* of the game is the task that needs to be learnt and the learning is not an adjunct - otherwise the player may learn to play the game and not the core material. That the expectations of the *clients* are understood and considered with the game, and that the *organisation* within the game reflects what would actually occur.

Game developers and teachers selecting games need to ensure that these three factors are in balance. This can be achieved by considering each attribute in turn. The criteria the Dutch researchers produced are intended to constitute a number of concrete design requirements for serious games. There is no reason these are invalid when selecting games.


Operation: Climate Control: Key Stage 4 players tackle climate change in teams through making choices within a scenario that can be modified by a teacher.
**www.operationclimatecontrol.co.uk**

# Discussion

Each model emphasises different aspects of serious games. RETAIN focuses on elements internal to the game. De Freitas and Oliver focus on the iterative process of game selection and integration. Harteveld and colleagues examine the need for balance between learning, game, and reality.

From all three models comes the importance of considering context. As summarised by Šisler and Brom:

"it essentially seems that when a game is supposed to be used in a formal school environment, the context of game-based learning is probably more important than the specific features and/or content of the game itself. By context here we mean both the contemporary educational practice, ie the national curricula, and the learning activities and discourse surrounding the particular educational game (eg supportive educational materials, students' presentations, teachers' lectures following the in-game experience, etc)." (Šisler & Brom 2008, p.11)

This concurs with Futurelab's earlier Teaching with Games project: if a commercial game is to be used effectively in classes there needs to be a clear consideration of how it will achieve the teachers' goals. Although not an explicit part of the models, the teacher will need to have a clear idea of the learning outcomes, whether it is understanding why, or knowing how to perform a task.

The integration of games requires a consideration of how it will be used with other practices to teach those learning goals. Reflection has been mentioned, both integrated and external to the game. This is vital, as Maria Klawe in 1998 demonstrated that if a player became immersed into a video game they were less likely to become aware of the mathematical structures and concepts that were integrated. This meant they may apply the knowledge in the game context, but not in other contexts (cited by Egenfeldt-Nielsen et al. 2008, p.218). Mediated discussions are not the only way of ensuring retention. If problems were written down when being solved as part of the game students were more able to transfer their learning (Klawe & Phillips 1995).

The context of game-based learning is probably more important than the specific features and/or content of the game itself.

Tactical Combat Casualty Care Simulation (TC3): trainee military medics play out scenarios in a virtual version of Afghanistan, where players have to treat wounded soldiers in the middle of battles and gunfire, testing a range of skills from how to treat the wound to bedside manner. **www.ecsorl.com/solutions/products/tactical-combat-casualty-care-simulation**

To summarise from these projects and other work, such as that by Simon Egenfeldt-Nielsen (2007) and the Teaching with Games project (Sandford et al. 2006), when selecting a game, in addition to practical considerations around access, hardware etc the teacher will need to consider:

- What is the background of the player(s) (age, language, experience, prior knowledge, preferred learning styles, etc)?
- What are the learning goals?
- How does the game content, that is, the factual knowledge contained, experiences, mechanics and activities, relate to the learning goals?
- How integral is the content to the game mechanics, processes, experience of playing as well as the art assets or copy, and is its acquisition required in order to progress?
- Will the game engage the learners - is it immersive?
- Does the game have a learning curve (ie do the players improve through repeated play), appropriate feedback, clear progression etc?
- What level of fidelity is appropriate?
- How will learning be transferred beyond the game context?
- How can the game be embedded and assessed?
- What other practices will support learning, either in the game such as reflection, or externally such as discussion?
- What retention rate, ie how long will the players remember the learning, will the game have?

Global Conflicts: Palestine: players explore and learn about different conflicts throughout the world and the underlying themes of democracy, human rights, globalization, terrorism, climate and poverty, through role play as a journalist interviewing protagonists in the game. **www.globalconflicts.eu**

Furthermore, the time taken for the teacher to master the game sufficiently to support the students and to recognise how it relates to the learning goals etc needs to be taken into account. Time is a major factor when it comes to incorporating alternative teaching methods into practice.

The identification of these questions suggests that a useful tool for teachers could be produced, involving a rubric of weightings of importance, as in the RETAIN model, but with an iterative approach as in de Freitas and Oliver's work. This may be addressed by the GFLI rubric, if not there is the need to create and test such a rubric from existing research. Regardless, there is a need for worked examples to demonstrate the process and timings whatever process is used.

# Conclusion



Games are tools, they can help us explore and understand issues, and train for various circumstances. Yet they rely on how they are interpreted, by the player or by support for the player, in order to change behaviour.

There are many advocates for using games, leisure and serious, simulations, and virtual worlds, in schools and for vocational training (as well as domains outside of formal education) to enhance and support learning (for example, Gee 2005; Smith 2006; Shaffer 2005). Moreover, the number of educational games with a research basis, that is, designed to address an educational need using theory, is increasing. The potential of digital games as learning tools will increase given the improving underlying technology, availability of kit, increasing interaction techniques, software's ability to process data, and the increase in gamers (JISC 2007). However there are barriers to using leisure and serious games as learning tools. Practical concerns include the licensing costs, IT support, and having sufficient kit. Teacher-based constraints include identifying an appropriate game, finding time to learn it, identifying what learning the student can gain, integrating it amongst the other learning tools within the lesson plans along with developing assessment techniques (Squire 2005; Egenfeldt-Nielsen et al. 2008; Sandford et al. 2006). As discussed, although games have been described as ideal assessment engines (Gee & Shaffer 2010) there is still a need to agree what needs to be assessed. The incorporation of assessment needs to be integral to the task - be it learning factual knowledge, social skills or procedures. Or the teacher needs to be supported in order to develop assessment techniques around the game.

If serious games, which are currently on the fringe of classroom use, are to become mainstream evidence of their effectiveness is required. This process is starting, for example the independent evaluation of the Consolarium. However there is little data on how games are used and how successfully they are integrated into teaching practice. There is no data about what subjects currently benefit from games, nor how they are used by teachers. Furthermore, such data could highlight to other teachers what is available and along with case studies illustrate possible usage. Secondly, teachers need to become more aware of what is available and how they can best be integrated and assessed (especially given many are not gamers). Finally, teachers and developers need to work together to agree not only topics and learning goals but metrics for assessment so that teachers are confident learning has occurred when a game has been used[67].

If serious games, which are currently on the fringe of classroom use, are to become mainstream evidence of their effectiveness is required.



**67.**
For a description of the proposed method for achieving this see Appendix E.

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# Appendices

# Appendix A. Selecting games

The following list is taken from the Digital Games Handbook (Felicia 2009). They apply to games in general and hence need to be considered for serious games.

**Hardware and technical specifications**
- Which operating software is required for the game?
- How much RAM (Random Access Memory) is recommended for the game to function properly?
- How much hard drive space is needed to install the game?
- Does the game need to be played over a network or an internet connection?
- What type of input device is needed to interact with the game (joystick, keyboard or mouse)?

**Game play considerations**
- User interface - should be clear, intuitive and easy to use
- Saving and loading the game
- Audio - a mute button for classroom use
- Customisation - the ability to personalise.

**Contextual considerations**
- Age group
- Language
- Time
- Taking account of people with disabilities
- Ensuring network games are safe for children.

**Pedagogical considerations - the game should have**
- A learning curve - easy to learn at the start and increasing
- Relevant educational content - including having clear objectives
- Clear progression
- Appropriate feedback
- Opportunities for collaboration and group work
- Assessment and follow-up
- Opportunities for creativity
- A help section.

# Appendix B. Questions in four-dimensional model

The following is the checklist within the four dimensional model that educators need to reflect on when choosing a serious game (de Freitas & Oliver 2006).

**Context**
- What is the context for learning? (eg school, university, home, a combination of several)
- Does the context affect learning? (eg level of resources, accessibility, technical support)
- How can links be made between context and practice?

**Learner specification**
- Who is the learner?
- What is their background and learning history?
- What are the learning styles/preferences?
- Who is the learner group?
- How can the learner or learner group be best supported?
- In what ways are the groups working together (eg singly, partially in groups) and what collaborative approaches could support this?

**Pedagogic considerations**
- Which pedagogic models and approaches are being used?
- Which pedagogic models and approaches might be the most effective?
- What are the curricula objectives? (list them)
- What are the learning outcomes?
- What are the learning activities?
- How can the learning activities and outcomes be achieved through existing games or simulations?
- How can the learning activities and outcomes be achieved through specially developed software (eg embedding into lesson plans)?
- How can briefing/debriefing be used to reinforce learning outcomes?

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

# Appendix C. Fidelity

Although there is not a model for deciding the appropriate level of fidelity needed for learning how a game emulates reality it is one of the key factors when deciding what game to select. Games can have three levels of fidelity: low, medium or high. Each level is suitable for different tasks. For example, if teaching how to bake under different altitudes a game could be simplified to remove elements outside the scope of the learning goal. This would include the selection of ingredients and physically creating the mix, but emphasising the time the mix bakes for and the altitude at which it is cooking. This low fidelity model is useful as it reduces the amount of data that might confuse the learner. While in military simulations there is a need for higher fidelity games, which are better at teaching step-by-step procedures.

To summarise, where the focus is on educating the learner (that is ensuring the learner understands why) about one abstract concept low fidelity models are likely to be appropriate. When training (so they understand how) higher fidelity models are likely to be appropriate. However, when the goal is for the player to understand abstract concepts rather than contexts either can be used.

To further complicate decisions not only are there different levels but there are three aspects within fidelity (Alexander et al. 2005, pp.4-6):

**Physical fidelity** - the degree to which the game behaves like real life
**Functional fidelity** - how the game behaves with respect to the real situation
**Psychological fidelity** - how accurately the game replicates the psychological factors in the real task

High levels of fidelity are required in all three areas of Triage Trainer. When diagnosing the order to treat patients the player needs to be presented a high level of accuracy in patient injuries, the process is identical to that needed in real life, and because of the time constraints and the realistic replication the player undergoes the same psychological factors as in a real incident.

The level of fidelity within each aspect does not have to be consistent. An example where psychological fidelity was felt to be important was the Code of Everand. The goal is to learn how to safely cross the road and that fidelity aspect has a high accuracy, yet nowhere is there a road - so functional fidelity is low.

However, again there are no hard and fast rules when deciding the level of fidelity required. Prof Bob Stone creates prototype games for the military and has written extensively about the human factors in these game designs. Given the need of the trainees he feels that fidelity is important, a bad decision can impair the learning benefits as discussed below:

"Background effects and scenarios should complement - and not interfere with - the task being performed. Therefore, as much Human Factors attention needs to be given to the content and fidelity of the scenario as to the design of the simulated tasks themselves. [...] the design and portrayal of avatars (virtual humans), "non-playable characters" and virtual agents, [...] constitute a special case of context fidelity. If strict attention is not paid to the design of their visual and behavioural qualities, then this can make or break the acceptance and credibility of the simulation at a very early stage."

# Appendix D. Interviews with experts

The interviewees were selected to give an overview of the serious games sector from diverse perspectives: the academic, games developers, instructional developers, commissioners and trainers (see Table 3 for an overview). They were intended to inform the literature review and inform future work.

A semi-structured interview schedule was used for each sector. All the interviewees were asked:

- How would you define serious games?
- When are serious games useful?
- What are serious games useful for?
- What serious games have you been involved in?
- What do you see the challenges of using serious games as?

Table 3 starts on the next page

The discussion with academics also addressed:

- How would you describe the underlying pedagogy within these games?
- Can you describe games that you have been involved with - development or use - (including Second Life) and your impressions?

The discussions with commissioners and developers included:

- What was the commissioning process?
- Who will use the serious game once made?
- What will they be learning?
- How will you know that they were useful?
- What time scale are you operating with?

**Table 3:**
Interviewees on serious games

| Name | Area |
|---|---|
| **Academics** | |
| Dr Diane Carr | Lecturer in games and education, and uses Second Life to lecture in |
| Dr Simon Egenfeldt-Nielsen | Has researched serious games extensively and developed Global Conflict: Palestine, which was awarded the BETT 2010 prize for best game. |
| Prof Richard Bartle | Lectures in games and game design and develops MUDs (multi-user dungeons) and worked on massively multiplayer online systems |
| **Developers** | |
| Mary Matthew, TruSim (Blitz Games Studios learning branch) | Develops serious games including Triage Trainer |
| Hannah Rowlands, Red Redemption | Developer of Climate Challenge for BBC and Operation Climate Control for DEFRA |
| **Commissioners and users of serious games as training tools** | |
| Peter Stidwell, Parliamentary Education services | Parliamentary Education Services commissioned the successful game MP for a Week, and are in the process of developing Time Chamber |
| John Hoggard, Lecturer in Defence Simulation | Teaches military to use serious games, and works to create them on Virtual BattleSpace platform |

To read the full interviews see **www.futurelab.org.uk/projects/games-in-education**

# Appendix E. Future work

From this research the following have been identified as areas where there is little information:

1. **Quantitative data on game usage:** There is little data on current serious game use within the formal educational system.
2. **Advice for teachers on using serious games:** There is no recognised guidance for teachers on how to select and use serious games within their teaching practice: although as stated there is generic advice around games from the European Schoolnet's project 'Digital Games in Schools' (Felicia 2009).
3. **Advice on developing appropriate game content and structure:** Identifying areas where games that would assist teaching could be created, and what an appropriate structure and assessment method useful for formal education would be in these cases.

These are elaborated below.

**Gathering quantitative data on game usage**
Currently there is little data on serious game usage in the UK. A European survey sent to teachers by Aarhus University in Denmark (**www.dpu.dk/site.aspx?p=11097**) and the forthcoming survey by Futurelab will gather data around:

- Why did the teacher select serious games as a teaching tool?
- What games are being used to teach specific topics to different ages?
- How long and how often are games used for?
- How successful are they at achieving the learning goals?
- What prevents teachers from using games as teaching tools?

However, the participants for these surveys will be self-selecting, and thus likely to be the most motivated and innovative teachers. There is no large scale survey of all teachers providing information on game-based learning in their practice. This data would allow: i) researchers and game developers to evaluate what games were currently being used in order to determine what game elements are required, ii) provide other teachers with information on what is successful and for what subjects. It could also act as a baseline to quantify the expected trends of increased use of serious games and raise awareness of the games available.

It is recommended that a large scale qualitative survey be performed looking at game use in the UK. It should focus on game-based learning in general, with a focus on serious games, their use and assessment.

**Advice for teachers on using serious games**

This report highlights that there is little support for teachers in identifying whether a serious game would aid their teaching. However, recently some work has begun on classifying the roles of teachers when they use games within their classroom: they can be an instructor, guide, explorer or playmaker (Hanghøj & Magnussen 2010).

It is recommended that workshops are held with researchers and teachers to clarify and combine the existing models of game selection discussed. The results would consist of clear guidance for teachers in how to select and incorporate a game into their lesson plan, assess learning, and support around blending with other teaching techniques. It would also include allowing teachers to recognise what role is appropriate for what part of the teaching activity.

The type of advice required is as follows:

i) An overview of serious game use in schools focusing on the advantages and disadvantages
ii) Examples of best practice and possible lesson plans
iii) Suggestions for use, eg subjects and goals that are supported through serious games

**Advice on developing appropriate game content and structure**

From Simon Egenfeldt-Nielsen's experience it appears that even if the pedagogy is sound and the game leads to learning, such as Global Conflict: Palestine, this does not translate to usage. Work needs to be done with teachers to:

i) Identify areas that games would be appropriate for. It is suggested that STEM areas might be one such area, as repeatedly running experiments might be dangerous or costly. Alternatively a learning goal might be better achieved by situating the concepts in the real world, for example, actually going through the process of urban renewal (Gee & Shaffer 2010). In these cases there is some evidence they will be more memorable and more transferable. However, if the learning goal is currently satisfactorily achieved by other teaching methods a game, however engaging, has a lower chance of being used. The goal is to identify areas which would make a teacher's life easier.
ii) Identify what elements teachers need within games in order for them to be useful. Do they require short, almost casual games, in virtual worlds to introduce concepts, must they closely correlate with curriculum requirements, do they need integrated tools of assessment that provide information required by the curriculum?

It is recommended that workshops are held with instructional designers, game developers and teachers to identify areas that would benefit from instruction via games. These would be hard to teach topics, subjects that would be too costly to investigate in real life, areas where concepts can be seen in an applied format. Once the areas are identified teachers could be informed of existing games that fulfil these remits.

Secondly, the workshops should consider game-play and preferred pedagogy as well as content area. Not only would this inform future game development by teachers and students creating their own game as well as providing a starting point for game development in general, it would be a starting point for analysing existing games. Is there a method of extracting the information around learning required through creating parallel tasks for example?

# Also from Futurelab

**Literature Reviews and Research Reports**
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Focusing on emergent ideas in education and technology, this series of publications opens up new areas for debate and discussion.

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# About Futurelab

Futurelab is an independent not-for-profit organisation that is dedicated to transforming teaching and learning, making it more relevant and engaging to 21st century learners through the use of innovative practice and technology. We have a long track record of researching and demonstrating innovative uses of technology and aim to support systemic change in education – and we are uniquely placed to bring together those with an interest in improving education from the policy, industry, research and practice communities to do this. Futurelab cannot do this work on its own. We rely on funding and partners from across the education community – policy, practice, local government, research and industry - to realise the full potential of our ideas, and so continue to create systemic change in education to benefit all learners.



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# Key to Themes

Futurelab understands that you may have specific areas of interest and so, in order to help you to determine the relevance of each project or publication to you, we have developed a series of themes (illustrated by icons). These themes are not intended to cover every aspect of innovation and education and, as such, you should not base your decision on whether or not to read this publication on the themes alone. The themes that relate to this publication appear on the front cover, overleaf, but a key to all of the current themes that we are using can be found here:

Digital Inclusion – How the design and use of digital technologies can promote educational equality

Teachers and Innovations – Innovative practices and resources that enhance learning and teaching

Learning Spaces – Creating transformed physical and virtual environments

Mobile Learning – Learning on the move, with or without handheld technology

Learner Voice – Listening and acting upon the voices of learners

Games and Learning – Using games for learning, with or without gaming technology

Informal Learning – Learning that occurs when, how and where the learner chooses, supported by digital technologies

Learning in Families – Children, parents and the extended family learning with and from one another

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