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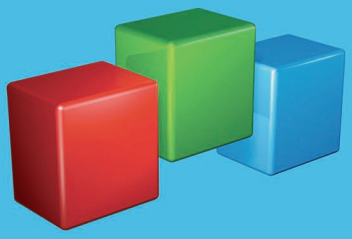
Computer Games & Gaming Metaphors as Effective Tools for Learning: A DISCUSSION PAPER



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Computer Games and Gaming Metaphors as Effective Tools for Learning: A Discussion Paper

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"I never try to teach my students anything. I only try to create an environment in which they can learn"
Albert Einstein

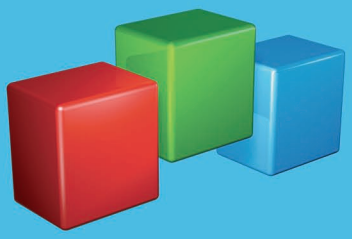
"CBT is on the coma end of the engagement spectrum; computer games occupy the other end"
Bob Filipczak, Training magazine

"Game designers have a better take on the nature of learning than curriculum designers"
Seymour Papert, MIT

"Tell me and I forget, show me and I remember, involve me and I learn"
Confucius

"Sure they have a short attention span – for the old ways of learning"
Edward Westhead, former University of Massachusetts biochemistry professor

"Anyone who makes a distinction between games and education clearly does not know the first thing about either one"
Marshall McLuhan



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Contents

1. Forward
2. Introduction
3. CBT and eLearning in 2005
4. Learning & Teaching Theory: A Brief foray
5. Computer Games for Entertainment
6. Computer Games for Learning
7. Emerging Technologies for eLearning
8. Conclusions & Predictions
9. Bibliography, Useful Links & Contact Details

1.0 Forward

This document is intended to act as a discussion paper for PIXELearning, it's partners and clients.

The author's objectives are two-fold; firstly to collate and assimilate the theories, research data and findings of others in the field and secondly, to provide a succinct, accurate and logical basis for the exploitation of a new, potentially large and exciting approach for developing and delivering education and training.

The reader should not infer that this document provides an in-depth analysis of any of the included topics, each of which could provide the basis for a thesis in their own right; rather it seeks to highlight relevant issues, drivers and characteristics upon which one can draw his or her own conclusions.

The author, coming from an online learning and web design background, does not purport to have an-in depth knowledge of the computer games industry. At thirty-five years old and with over twenty years experience of using computer-based games, he does represent however, the typical gamer (Prensky,2000).

The author is keen to stimulate discussion on this subject and as such the reader is encouraged to provide comments, criticism and suggestions. The author can be contacted by sending an email to kevin.corti@pixelearning.com or via the contact information provided on the back page of this document.

2.0 Introduction

In my 25 years as a computer and computer games user, my 11 years as a web designer and my 8 years as an eLearning developer, I have used computers and the internet to write a thesis, conduct auctions, buy CD's, books and other assorted goods, found friends and colleagues, organised my calendar, transferred money, paid bills, sold a motorbike, found well-paid jobs, communicated with people in dozens of countries around the world, created music, created thousands of web pages, solved technical problems, undertaken research, played games, watched TV programmes and lectures, listened to live sport and even found the house that I now live in.

If I need to learn how to use a new software package I start it up and play with it. If I do not understand enough about a programming syntax, or if I want to learn about a particular business topic I search web sites and newsgroups for appropriate information, technical support and user case studies. If my PC fails to operate smoothly, I locate, hints, tips, step-by-step guides, advice and download suitable hardware drivers and operating system patches. The web has become my primary source of knowledge, information retrieval and self-guided learning.

In the same time, I have never completed a computer-based course for my own learning purposes. I find this worrying because I do not believe that I am by any means unique. I believe that this says much about the inappropriateness and ineffectiveness of the pedagogical methodologies that are regularly applied to eLearning instructional design.

A few years ago I decided that it was about time that I got to grips with Active Server Pages. I found a free course online but gave it up within an hour and bought a book instead. Why would I 'waste' £50 when I had access to a free online course? The reason; because if I am going to read text I would rather read it from a book than from a computer screen; because the book provided a far greater depth and breadth to the subject matter, it was easy to jump sections that I found irrelevant and concentrate on sections that I found difficult; and because the book was supported by an accompanying CD-ROM that gave me code examples and useful software with which I could practise.

This is the context in which this discussion paper was written, a context that I believe has a certain commonality to the vast majority of my generation and the generations that are following it.

3.0 CBT and eLearning in 2005

The term 'eLearning' is now commonly used as a catchall for any kinds of technology-based learning solutions. Towards the end of the 20th Century it replaced previous acronyms and terms such as 'Web-Based Training' (WBT) and 'Computer-Based Training' (CBT), a term that is widely used to describe a pre-Internet era of technology use for education and training. It is questionable however, whether eLearning practitioners have, in the main, embraced the advent of Internet technologies with appropriate instructional approaches that take into account the wealth of new opportunities that the Internet offers let alone reflect the needs of what Mark Prensky calls 'The Games' Generation[1].

Many organisations of all sizes rushed to embrace this new medium for corporate training towards the end of the 20th century[2]. Many sound business cases were cited, but in retrospect, it would appear that a dramatic reduction in training costs was the main motivation for making this jump. Industry publications such as IT Training and IT Skills, frequently told their readers about multi-million pound savings that had been achieved[3] and for a time the industry was intoxicated with the opportunities for reducing overheads, increasing margins in competitive markets and delivering increased shareholder value. However since 1999, many people have come to question the true effectiveness of the nature of the eLearning solutions that were implemented during the later half of the 1990's. Many people have raised concerns about the quality of the learning experience; about the lack of research into the educational effectiveness of eLearning; about the often disturbingly high drop out rates[4], or conversely, the suspiciously high pass rates.

The author can recount an experience in 1998, when designing a web-based customer care course, he was asked by the client, an experienced and capable management trainer, to include a 'game' to make the course more 'exciting and interactive'. By no means averse to taking on board the ideas of his peers (and clients), the author listened with an ever-increasing sense of amusement, whilst the trainer detailed how the screen would display a frog that jumped from lily to lily across a flowing river after the student answered a question correctly. If the student got the answer wrong (the questions were of the 'true' or 'false' variety), the frog it was explained with great excitement, would fall into the river and be washed off the screen.

This is a classic example of a trainer/educationalist, who was experienced at (successfully) deploying traditional instructional techniques in the classroom, completely failing to understand the medium of computer-based learning. His suggestion may well have provided a brief moment of light-hearted relief for his students, yet he sincerely believed that this was an appropriate approach to instilling in his students an understanding of the fundamentals of customer care. The suggested 'game' also would have allowed the student to fail, i.e. their frog would have fallen into the river, and thus the student would be unable to move onto the next question. The author has no doubt that the student would be aware that they had answered incorrectly, but suspects that they would be more pre-occupied with the plight of the struggling amphibian than with their lack of understanding of the subject matter at hand. In the end, a compromise was achieved where the nature of the game centred around the scenario of a fictitious job interview for the position of Customer Care Manager, and the eventual success or failure was determined by the students overall ability to answer all the questions.

The author has always stood by the premise that eLearning, whatever the chosen pedagogic approach, should be appropriate, effective and in most cases efficient (i.e. affordable). Asking twenty-something trainee managers to make frogs jump across a river, as part of their customer care training is arguably inappropriate and thus unlikely to be effective. If any training fails to be effective, it can hardly be claimed to be efficient.

The author recently attended the inaugural Learning Lab[5] annual conference at the University of Wolverhampton. During one particular session he put it to a panel of experts that there seemed to be a common misconception that the publishing of content online was the same as providing an effective learning experience and that much of the eLearning content that had been developed to date was very boring for the learners to use. Several members of the panel, to their credit, acknowledged this problem and expressed a desire for change. One person, who represented a regional Learning and Skills Council, gave a response that the author totally disagrees with. He stated that it was the industry's fault for raising expectations and that it was our duty as practitioners to "tell the user beforehand that a course is going to be boring, but highlight the benefits of completing it."

It is the author's contention that the old 'carrot and stick' approach to motivating and engaging learners is well past it's sell by date. We live in a country where there is currently chronic skills shortages in IT, teaching, health and other professions yet where there is still over a million registered unemployed workers; a country where there is massive ongoing debate about the quality of education in our schools, colleges and universities; and a country in which our school leavers, graduates, companies and institutions compete daily in a global economy that is witnessing large-scale changes and which presents difficult challenges in the short, medium and long terms.

In the UK, we live in a country that has the world's fourth largest economy, the higher education system of which is respected the world over, that excels at technological innovation, that has wide-spread Internet usage and which should be capable of utilising these factors to position itself and it's population at the forefront of the 21st century economy. Education and training is vitally important to this process and will become evermore so. Our ability to utilise technology-based learning effectively will be a major factor in the eventual success or failure in this endeavour.

We live and work in an increasingly interconnected and interdependent world. The 'global village' of the 1960's(Marshall McLuhan, 1967) is now a reality. How will we as a nation, create high-quality, well-paid 21st century jobs for the sons and daughters of today's car workers, steelworkers, call-centre operatives and component assemblers when, by the end of this decade, the annual number of Brazilian graduates will exceed the total population of Scotland[6]? Industries will locate where there is skilled labour available whilst continuing to automate tasks and processes that are today carried out by employees. If the United Kingdom is to be able to maintain it's position, let alone build upon it, education, training and professional development professionals will need to introduce innovative ideas, processes and methodologies to the learning process.

In the early part of the 20th century, manufacturers started to make use of plastic materials. At first it was made to look like wood and used to replace wooden parts, for example, in car interiors. Car owners ended up with parts made out of plastic that looked like what they were; a poor imitation of wood. The manufacturers were taking a new, exciting technology that offered many new opportunities and using it inappropriately to do the things that another existing technology already did better. Many organisations spent vast sums of money in the 1990's acquiring eLearning infrastructure, content and services that were based on, or designed for traditional teaching and learning approaches, but ended up being ineffective and inappropriate; poor imitations of learning environments and processes.

The practitioners of eLearning need to start thinking in new terms that are appropriate for this medium and which allow our schools, colleges, universities and companies to leverage the true potential of eLearning. That comes from an emphasis not on the technology requirements but rather from an emphasis on the needs of the learner, and the learner of today is a markedly different animal to his predecessors for he/she is most likely to be of Prensky's 'Games Generation'[7]. The practitioners of eLearning need to start thinking in new terms as illustrated in figure 1 overleaf:

Relevance to the learner NOT generic products
Adaptive programmes NOT off-the-shelf products
Byte-size-chunks NOT six hour lumps
Parallel NOT linear
Open-ended NOT closed loop
Just-in-time NOT when scheduled
Connected NOT standalone
Engage NOT switch off
Active participation NOT passive dissemination
Fun NOT boredom
Learning by doing NOT learning by telling
Learn by failing NOT fail but trying
Peer-to-peer NOT one-to-many
Simulation NOT assimilation
Role-play NOT no-play

Fig 1: New ways of thinking for effective learning

4.0 Learning & Teaching Theory: A Brief foray

The purpose of this document is not to demonstrate some radical new learning or teaching theory. Rather it is to demonstrate that the effective use of the Internet as a delivery mechanism of learning material requires that developers understand the fundamentals of educational theory if they are to be able to develop effective, efficient and appropriate material for their target user group. It is therefore appropriate to devote some space to review some of the learning and teaching theories that are in existence in different applications as it is important to apply aspects of these to a framework for the eLearning development process.

It is very easy to quickly become inundated with dozens if not hundreds of what purport to be unique theories on how people learn. The Web-Based Training Centre[8] for example, describes at least ten theories which to the first time reader at lest, are hard to differentiate between. The Theories Into Practice database[9] lists over fifty different theories "relevant to human learning and instruction".

To even begin to research these in any depth would entail a thesis on its own and one that has undoubtedly been done many times. It is necessary none-the-less to examine some of the key points made by practitioners and researchers alike in order to set the context in which the argument for a development process is made. It would serve little purpose to choose one particular theory of learning or instruction, as they are more than often intricately linked with several others. For example Kearsley attributes Constructivist theory, which is covered more lately in this section,[10] to the numerous works of Bruner. Bruner's work was itself based upon research into child development by Piaget. Imagine if an instructor set out with the intention of developing educational material for say, an undergraduate level engineering course, based purely on a constructivist approach.

Engineering represents a major category of adult education that is critical to most aspects of modern society. Kearsley describes the role of the engineer and refers to several, quite different cognitive processes, each of which can be justifiably applied to different aspects of the engineer's role[11].

They are:

- Problem solving and reasoning. (Florman, 1976)[12].
- Mathematics.
- Innovation and inventiveness. (Therefore creativity is important).
- Social learning and development, (e.g. Bandura, Vygotsky) as most engineering activities are undertaken in a team environment.
- Most engineers must perform some form of management function, an area that often requires intensive instruction.
- Self-directed and experiential learning (Cross, Knowles, and Rogers) are important as like any profession, engineers need to engage in lifelong learning to stay current or to advance in their field.
- Engineers in the modern business-driven world must also exhibit strong communicative skills, be rigorous in the management of commitments and achieving quality standards (Denning 1992)[13].

It can be seen that a pure adoption of an exclusively Constructivist approach towards the development of engineering material could well lead to the exclusion of several other approaches that are perhaps, more appropriate for particular cognitive processes. An awareness of the most useful approaches and their applications is therefore useful for the purposes of establishing the basis upon which the framework for a development process is based.

Shirley Alexander (1996) also felt it necessary to go back to learning theory when discussing teaching and learning on the World Wide Web. She refers to work by Saljo (1979) which she describes as "one of the most widely respected studies". Saljo carried out interview studies to determine what individuals understood by the term 'learning'.

This lead to the development of five categories, which are detailed below:

Learning as:

- A quantitative increase in knowledge.
- Memorising.
- Acquiring facts.
- Making sense or abstracting meaning.
- Interpreting and understanding reality in a different way.

Alexander refers to Ramsden (1992) who differentiates the first three conceptions from the last two. He states the first three conceptions imply a less complex understanding of what learning is, typically as something that occurs externally to the learner.

Conceptions four and five emphasise the internal or personal aspect of learning: "learning is something that you do in order to understand the real world, rather than something done by someone or something to the learner."

This contrast in approaches is identified as of being of the two extremes of Pedagogical philosophy (Reeves & Reeves, 1997). The two extremes are described as Instructivist and Constructivist, where an Instructivist would: "stress the importance of objectives that exist apart from the learner", whilst a constructivist pedagogical philosophy emphasises: "the primacy of the learners' intentions, experiences and cognitive strategies."[14]
Progressing on from this is what Alexander describes as "approaches to learning" that students can be seen to adopt. These she describes as "deep" and "surface": "Students who engage in a learning task with the intention of understanding or seeking meaning are said to be adopting a deep approach". Conversely those who set out with the intention to memorise facts or figures are said to be adopting a surface approach.

Surface approaches to learning are associated with poor quality learning outcomes and deep approaches to learning with high quality learning outcomes (Entwistle and Ramsden 1983 and Watkins 1983). If this is the case then the learning strategies that encourage deep learning approaches are critical to the effectiveness of any educational programme.

It is true that some subjects and levels of teaching only require the transfer from the teacher to the student, of a quantity of core information. This is sometimes referred to as 'knowledge-based' information. Examples of this type of information may be dates of events, or the lead up to a specific event, say in a history lesson. That is appropriate if all that is required of the learner is that they know what happened and when. This might be associated with the early stages of a course or curriculum where the goal is to build a basis upon which higher level, conceptual level of instruction can develop at a later stage.

It may also be appropriate in a training application where the goal is to enable the learner to be able to carry out a specific function in their employment. If however they are expected to understand why an event happened or perhaps why something else did not, then it can be seen that a deep approach to learning would be desirable if the required, high quality learning outcomes are to be achieved. When this is so, it is necessary that to ensure that the learner is required to devote a higher level of thinking to the course.

What is lacking in much of traditional distance teaching is active participation and meaningful, higher level thinking (Dodge 1996)[15]. Dodge identifies two "fundamentally different approaches to teaching". The first approach is to: "transfer, as effectively and efficiently as possible, a concise and coherent block of information from the teacher or computer, into the minds of the learners." These kinds of distance (and classroom) taught lessons, he characterises as having simplified content and "a limited number of paths through the lesson".

We can see that the nature of the approach encourages the first three of Saljo's categories of conception of learning, i.e. learning as acquiring information, as storing information that can be retrieved and used as necessary. Dodge describes this approach as; "useful where the content is well defined and stable", but we would expect Alexander to characterise it as fostering a surface approach to learning.

The second approach that Dodge describes is the constructivist approach. This involves the bringing to bear of multiple perspectives, where; "the learner is provided with tasks and opportunities, information resources and support and is encouraged to construct their own version of the content, subject to revision through feedback." This type of approach to teaching results in courses that allow multiple paths through the course and which positively encourage collaboration with other learners.

Constructivism is; "a philosophy of learning founded on the premise that, by reflecting on our own experiences, we construct our own understanding of the world we live in. Each of us generates our own 'rules' and 'mental models' which we use to make sense of our experiences."
As such it must be the goal of the teacher to provide an environment that allows the learner to generate these 'mental models' to a degree of accuracy that ensures that the learner is equipped to deal effectively with a problem or situation.

The focus is on the search for meaning, not on facts and figures and as such clearly fits in with Alexander's definition of deep learning approaches. If we are to encourage a deep approach to learning in an educational programme, it is important to provide the student with the satisfactory positive motivator to choose this approach.

Dorman Woodall[16] identifies this when making his argument that; "key elements can make a dramatic difference in the effective design and delivery of instruction to adult learners." He states that using these "key elements" in a training program will motivate the learners to commence upon the course, to stay on it, to gain confidence and satisfaction for the duration of the course and to complete it with a new set of knowledge and skills that they are able to apply to real-life situations. Woodall divides these basic elements into three categories, which are based upon different psychological approaches.

The first category is based on Motivational elements. Woodall states that: "Humanistic psychologists tell us that the way people feel about an endeavour influences their commitment to it. That is to say that if the 'student' feels "secure, respected, esteemed, empowered, in charge, they are likely to make an investment in it".

Woodall derives his second category, Information-Processing, from what he says that cognitive psychologists tell us. That is that: "Information is more likely to be acquired, retained, and retrieved for future use if it is learner-constructed, meaningful, relevant, builds on prior knowledge, is logically organised in learnable chunks, and has built-in or learner generated memory devices to assist in retention and use of the information for the future".

Woodall's third category is Behaviour change. He states that behavioural psychologists tell us that this is brought about by learning experiences that include the following elements:

- **Observation and imitation of role models**
- **Guided, spaced practice with specific feedback on the student's performance**
- **Positive reinforcements for the student's efforts**
- **Practice in applying and using the new learning in a variety of situations**

It can be seen that according to Woodall, these three key elements must be satisfied in order if the desired learning outcomes are to be realised. That is to say that the students must become actively engaged by choice (motivated), presented with well organised course materials (to enable information-processing) and this must be done in an environment that encourages them to adopt new techniques and approaches (behaviour change). Woodall provides the reader with more detailed, 'practical tips' for the development of learning material that incorporates his three key elements.

Biggs and Telfer (1987) suggest that an appropriate motivational context, along with a high degree of learning activity, interaction with others and a well-structured knowledge base all serve to foster deep learning approaches. Alexander also refers to the work of Laurillard (1993) who discusses a number of key aspects of learning pertinent to a discussion about teaching strategies.

The key aspects are:

Apprehending structure. According to Laurillard: "Meaning is given through structure" and it is therefore essential that students are able to interpret the structure of a discourse before being able to grasp the meaning. Alexander argues that students who adopt a surface approach to learning would fail to do this, as they would naturally concentrate upon memorizing key facts and figures for reproduction at a later stage.

Integrating parts. Alexander defines this as; "the need to be able to integrate the knowledge such as language, symbols, diagrams with what is signified by them."

Acting on the world. This describes the setting of tasks whether it is the writing of an essay or a practical experiment in a laboratory. This engagement in an activity, when integrated with the other elements described here, assists in the understanding of the content.

Using feedback. Alexander states that the setting of activities is futile for student learning if individualised feedback is not provided.

Reflecting on goals-action-feedback. This simply describes the process of constructing an understanding of an overall concept by reflecting on the goals of learning, the actions that were taken and the direct results of those actions.

In this section we have briefly explored some relevant educational principles that should be applied to eLearning applications and content in order to achieve an effective learning experience on the part of the learner, but how do we actually go about this at the operational level? This paper is based on the contention that games and game metaphors can be utilised to create second-generation eLearning; technology-based learning that is far more effective than the traditional CBT/static web page model.
In order to investigate the possible incorporation of games and gaming metaphors for learning purposes, it is necessary to first look at 'traditional' games and the gaming industry.

5.0 Games for Entertainment

5.1 Genres and characteristics

If one is asked to think of examples of 'typical' computer games, it is often the big-budget titles such as the Tomb Raider series and Age of Empires that come to mind; titles with highly-detailed characters and objects, expansive 3D worlds, gripping visual and audio effects and in-depth scenarios, storylines, tasks and objectives. Yet one of the most successful games (in terms of numbers of users) was and continues to be Tetris, an incredibly simple game that can be mimicked and built from scratch in a few days. There are many genres of games and they are developed for a wide variety of audiences, budgets and deployment platforms.

It is important therefore, when asking the question; "what are the characteristics of a good computer game", to contextualise the responses in terms of the respondents age, experience, mode of (games) usage, educational/academic experience and personal perceptions, familiarity and understanding. It will be equally important to remember this point when we come to assessing the characteristics of games that might be considered for use within a learning solution.

In 2001 the British Educational Communications Technology Agency (BECTa) published their research findings and a literature review for their Computer Games for Education (GCE) Project. Within it's findings, BECTa identified seventeen categories of games, a list of which is reproduced in Figure 1.

It is worth noting that BECTa state that the categories often overlap and that the list is not exhaustive.

Action-Adventure	**Platformer**
Action-Strategy	**Puzle**
Arcade	**Role play**
Beat-em-up	**RPG**
Bemani	**Shoot-em-up**
Driving	**SIM**
Email games	**Sport**
First Person Shooter	**Strategy**
Mech	

Fig 2: BECTa list of game types

It is clear, when looking at the list of games shown in Figure 2, that there are a wide variety of game types. If one considers some of the titles that fit within one (or more) of these categories, it also becomes clear that the Games Industry has at it's disposal, a diverse range of approaches (or dare we say it, 'pedagogies'?) in it's quest to produce effective, engaging, appealing and thus, commercially successful games titles.

Archetypal examples such as Quake, the Tomb Raider series, Myst and Sim City represent the use of different types of game play whether it is First-Person Shooter, Action-Adventure, Role Play or SIM. The objectives that the gamer must achieve to succeed may vary from the more simplistic 'roam around and shoot all the baddies' to mastering a rich and diverse strategy to build and run an intensely detailed and constantly evolving city.

Does the computer games industry therefore possess a 'taxonomy' for effective game design? We shall consider this later when we come to consider how games and gaming metaphors might be integrated into eLearning solutions.

5.2 The economics of computer games for entertainment

One thing that all the games mentioned previously have in common, even when the games categorisation and type of game play differ, is that they offer a highly impressive visual experience, whether in terms of detailed rendering of topographical surfaces or polygon-built 3D shapes, smooth animations, realistic moving characters or fastidiously detailed objects.

Although, as was stated earlier, one of the most successful games ever produced is Tetris, it is fair to say, in general terms, that most successful entertainment games titles offer a rich, impressive audio visual experience.

The price of a typical games title varies between £20 and £40 for PC, PlayStation, Nintendo and other platforms. Successful titles ship hundreds of thousands or even millions of units in the first year of release, generating tens of millions of pounds of revenue for the publishers and developers.

In order to maintain a competitive edge however, games developers require enormous development budgets, often up to £10 million when marketing costs are included. This budget comprises of a few main elements; the development or acquisition of 3D, physics and other 'engines'; the creation of art assets (e.g. characters, objects and landscapes), the creation of the game 'logic', storyline and scenario structure; and advertising and marketing spend.

The days of the cottage computer games industry are long gone. As the Games Industry has evolved it has spawned dozens of niche companies that specialise in certain elements of the games development process, namely content development, middleware and publishers. Companies such as Lithotec provide software that the content developers utilise to turn their ideas into commercial products without having to invest large amounts of time and money in developing the application logic to power, for example, collision detection, 3D navigation, world creation and gravitational effects. Similarly games developers can license the 3D engine technology that was originally developed for Quake, for use in their own games. This is done in the interest of time-to-market and budget constraints.

Seen in the context of most education and training programmes however, the same advantage is not so obvious when one examines the costs involved. It currently costs around £40,000 to acquire a single license for the PlayStation 2 and XBOX developer's kits. The Lithotec games development software, which it is probably fair to characterise as being able to produce average quality games, costs around US$250,000. Given that licensing the Quake 3D engine costs around £500,000 per platform per title, it's use on one game that is developed on, for example, Sony's PlayStation 2, Microsoft's XBOX, Nintendo's Game Cube and PC, would cost £2,000,000. That is before a single line of code is written or before a single image has been created.

Although there have been many hundreds of companies and organisations that have and are developing games for educational purposes, the vast majority of games 'titles' that are widely recognised (and that have generated large sales revenues) have been developed purely for the entertainment market. Games titles such as Sim City, Command and Conquer, Black and White, Grand Tourismo, Age of Empires and Tekken have sold millions of units worldwide. Publishers of successful titles often benefit from enormously successful merchandising spin-off's and some titles, such as Mortal Combat, Tomb Raider and Final Fantasy, even lend their story lines and characters to major Hollywood movies.

The Games Industry recognises that it is part of a wider entertainment industry and is able to exploit the opportunities this generates for wider commercial gain. Companies such as Nintendo, actively seek out game concepts that are based upon instantly recognisable characters that children will most likely associate with, that can then be licensed for use on hundreds of different products from lunch boxes and sweets to T-shirts and stationary. The economics of computer-games for entertainment are clearly different to the economics of computer games for education.

5.3 Typical gamers and the 'gamer stereotype'

Despite the massive numbers of people who regularly play computer games, there still exists a strong stereotype of the typical gamer as someone who is young, somewhat 'nerdy', unable to communicate, introverted and lacking in basic social skills. Parents and teachers often express concern about the amount of time that children spend on computer games consoles and PC's. It is interesting to recall that the same concerns were expressed throughout the 1970's and 1980's about the amount of time that children spent watching television, when now this argument is much less-often made and in fact, many parents would prefer that their children watched a 'stimulating' television programme rather than playing a computer game. Is it true that the average computer games player is likely to be young? According to Mark Prensky the age of the average computer games player is thirty-one[17]. Prensky talks about the 'Games Generation', which he defines as constituting of those people who are; "native speakers of the digital language of computers, video games and the Internet." The Games Generation, he argues, are 'wired differently', and thus require and demand different modes of communication, stimuli, collaboration and motivation to people who are perhaps conversant with the digital era, but were not born into to it.

Prensky identifies ten cognitive style changes that differentiate members of his 'Games Generation' from people that were born before them.

- **Twitch speed vs. conventional speed**
- **Parallel processing vs. linear processing**
- **Graphics first vs. text first**
- **Random access vs. step-by-step**
- **Connected vs. standalone**
- **Active vs. passive**
- **Play vs. work**
- **Payoff vs. patience**
- **Fantasy vs. reality**
- **Technology-as-a-friend vs. technology-as-a-foe**

If Prensky's conclusions are correct, they represent serious challenges for those who are responsible for providing education and training to members of the Games Generation.

5.4 Contentious issues

If the eLearning industry hopes to benefit from the advantages of using gaming in educational software then it will also have to deal with the real and perceived negative aspects of computer games namely concerns over the effects of on-screen violence, gender bias issues, the 'cheat' culture, social exclusion and 'techno phobia'.

It is not the intention of this paper to explore these in great detail, but the point must be made that these are very real concerns that are often expressed, and as such the eLearning industry had better get to grips with these issues if it hopes to be able to develop products and services that are effective and commercially viable.

5.5 Gaming Technology

With the potential for seven and even eight figure revenues and the intense competition between companies that results, it is easy to understand why the entertainment games industry is quick to develop, acquire and improve new technology. The development of a top entertainment title will involve development companies that have access to dozens of highly skilled and experienced programmers and extremely powerful software tools. Games programmers represent people who are at the top of the profession and as a consequence can command salaries up to £60,000 per annum. With millions of pounds available for development, and the absolute need to offer cutting edge gaming experiences, companies will invest heavily in technologies such as Artificial intelligence (AI), 3D capabilities and online gaming.

AI allows games developers to create game characters and/or objects (e.g. space ships or aircraft) that behave intelligently in response to the actions of the human user in order to provide a far more stimulating and challenging gaming experience. The Quake 3D engine is legendary in gaming circles. Games that use it or other similar technologies provide an increasingly realistic virtual experience, the quality of which goes far beyond anything seen on commercial web sites or traditional eLearning packages. The online capabilities of PC's and game consoles such as the Sony PlayStation 2, allow users to play with or against each other in real time irrespective of the geographical distance between them.

Another interesting feature of entertainment-based computer games is the incorporation of design tools that allow the gamer to create their own characters, environments and worlds. They are often able to publish these on the web for others to use.

The Games Generation will expect this level of technology from an educational games package. Managing this level of expectation will be critical if second generation eLearning is to be successful.

6.0 Computer Games for Learning

6.1 The appeal of games for eLearning

The potential of games and gaming metaphors for learning is becoming increasingly appealing to educators and trainers alike, but for what reasons? What are the characteristics of games that are appealing to trainers and educationalists?

A quick brainstorming session would typically yield the following or similar key words:

CAPTIVATION / IMMERSIVE / ENGAGING / MOTIVATING / MAINTAINING THE 'FLOW' / ACTION / MULTIMEDIA / EYE-CANDY / STIMULATION

CHALLENGE / ACHIEVEMENT / QUESTS / TASKS & MISSIONS/ OBJECTIVES / RULES / FLOW / STRUCTURE / ORDER / PATHS / LEVELS

SELF-DIRECTED / ENQUIRY / CHEATS / ATTEMPT / LOCATE / SEEK / FIND / RISK / ACTIONS AND CONSEQUENCES / DECISIONS / OUTCOMES / REWARDS / FEEDBACK / RESULTS

SIMULATION / ROLE-PLAY / STRATEGY

SYNTHESIS / ANALYSIS / JUDGEMENT / EVALUATION / APPLICATION / EVALUATION

ADAPTIVE / RESPONSIVE / HINTS / TIPS / DIFFICULTY / INTELLIGENT OPPONENTS

Fig 3: Words associated with computer games

The list above is by no means exhaustive, but indicates a number of key characteristics or factors: Attention-grabbing Qualities, Achievement Factors, User Approaches, Genres, Cognitive Approaches and Difficulty Pitching.

Which of these factors represent benefits in terms of educational games and how do designers ensure that they are effective games and as a result, effective learning packages?

6.2 Attention-grabbing Qualities

We live in the 'MTV age'. Today's children belong to the 'Nintendo Generation'. Music videos typically contain hundreds of camera shots per minute. Movies launch into expensive action sequences within minutes of starting. The attention span of the younger generations has got shorter and shorter representing a major challenge to educators, marketers and parents alike. Einstein.tv schedules it's television programming around small byte-sized 'infotainment' programmes of no more than 5 or 6 minutes because they recognise that that is what their audience responds to.

If we want to be able to deliver truly effective, technology-based (and traditional) education and training events, then they need to incorporate techniques that maintain the learner's attention and interest. Very few industries understand this as well as the computer games industry. The moment a gamer looses interest is the moment that the game has failed and disenchanted customers rarely return to buy subsequent products in such an intensely competitive market.

Developers and publishers of eLearning content can benefit greatly from these Attention-grabbing Techniques if they are applied in a way that ensures that the learning experience is significantly enhanced on the part of the learner. The 'Holy Grail' for the eLearning industry is to develop truly effective learning experiences that are able to capture people's attention in the same way that Doom or Tomb Raider is able to do.

6.3 Achievement Factors

Games have objectives. Gamers do not run around 3D worlds, explore levels, chase aliens or drive vehicles without purpose. They do so in order to kill the bad guys, save the princess or escape 'the law'. Ultimately there is a purpose to a game and this is accompanies by rules and game structure. Gamers are faced with tasks, missions and attainable goals. The rules may be rigid or flexible, in-depth or extremely simple, but they exist and the gamer is either told the rules or allowed to find them out by experimentation.

In this respect this is very similar to a learning programme. The objective is to transfer knowledge and/or to enable understanding. No teacher would simply provide students with a textbook and then leave the classroom. We would hope that the teacher would at least direct his/her students to the passages that they were expected to read and explain what it is that the students were expected to do with the information at the end of the session. In effect the teacher is applying 'structure' to the learning experience, by defining the 'rules', the required outcomes and the learning objective(s).

6.4 User Approaches

Some games such as Space Invaders offer a very narrow range of approaches, i.e. 'move left or right and shoot the aliens before they shoot you.' Other games such as Sim City, Halo and Grand Theft Auto are far more complex and we would expect to see users experiment with a multitude of different approaches to achieving the given objectives. Often the most successful games are flexible to allow different gamers to succeed using different approaches, i.e. the gamer is able to use their individual strengths, skills and experience to succeed in the game to complete it, to win. Games are designed in a way that rewards innovation, initiative, ingenuity, creativity and persistence, an admirable approach that would transfer very well from an entertainment driven approach to an educational one.

Educational games developers should consider this and allow for different learning styles and approaches. We might, for example, provide a rich 3D world based on an ancient city for the purposes of allowing the learner to gain an in-depth understanding of the social, technological, economic and political issues that were prevalent at when the city was in it's ascendancy. We should then provide educational content that appeals to learners' different learning styles, i.e. whether they are visual, auditory or kinaesthetic learners. We should allow learners to explore the city unaided and to achieve the same level of comprehension of the issues as achieved by the learner who is given a virtual guided tour by their teacher. The learner who prefers to read and digest text-based content should be able to achieve the same learning outcomes as does the learner who prefers a more audiovisual approach and vice versa.

6.5 Genres

As demonstrated in Fig 2, there are many different genres of entertainment games. People tend to prefer certain genres at certain times in their lives. Likewise, it would be inappropriate to force only certain educational games genres on people. Some learners will respond better to slow-paced, role-play type educational packages and others will respond best to educational games that offer some form of fast action-based activities.

6.6 Cognitive Approaches

Most educationalists will be familiar with Benjamin Bloom's taxonomy of cognitive objectives (Bloom's Taxonomy). This describes six categories, or levels, or cognitive activities, which get progressively more, advanced: Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation. We can associate these with Alexander's 'Approaches to Learning', ranging from shallow/surface learning to deep learning.

Instructional designers of educational games may do well to apply the appropriate level of cognitive activity to the target audience. It would probably be inappropriate to require that a class of 6-year olds to provide a critique of a work of art. We would most likely ask them to 'describe' it. Likewise it would may be appropriate to require that a company CEO identifies a selection of objects using a drag and drop exercise. The required cognitive approaches should reflect the abilities, experience and aptitudes of the learners.

6.7 Difficulty Pitching

Gamers get bored when games are ridiculously easy and get frustrated when they are ridiculously hard. Good computer games respond to how well the gamer is performing but adjusting the parameters of the challenge in order to maintain the gamers' interest. This may be by altering the number of enemy soldiers in an action game or by providing extra clues in a strategy game. The objective of an entertainment game is to complete it (to win) in order to gain satisfaction (and perhaps to be able to brag). The objective of an educational game is the same only the ulterior motive is that in doing this, the game also allows effective learning to take place.

Consideration should be given to ways in which the user's performance can be monitored and, if necessary, for certain parameters within the game to alter to maintain the expectation of success and the satisfaction of playing.

7.0 Emerging Technologies for eLearning

7.1 Connectivity

The most obvious differentiator between the type of technology-based learning that we presently term as 'eLearning' and that, which came before it, is connectivity. Connectivity to the public Internet and also to private intranets (private computer networks which are based upon internet technologies), gave learners almost instantaneous access to a rapidly increasing, virtual library of content. Connectivity has two elements to it however: the connections between learners, peers and mentors; and the connectivity of the learning process to other business processes.

7.1.1 Connections with others

Everyone involved in the use, design, support and management of learning can now be connected irrespective of geographical location and time differences. The use of email, discussion boards, notice boards, chat rooms, interactive white boards, file sharing desktop sharing and peer-to-peer software means that we have a basis for effective communication and collaboration. If people can play each other at Quake in real time from computers all over the world then there is no reason why they cannot learn together. Technology-based learning need no longer be a solitary experience; indeed the relative anonymity has been shown to encourage shy students to participate more than they would in a classroom environment. It is this word environment that is the key. People gain information from content but they need an environment to acquire knowledge, an environment that encourages communication, interaction with others, experimentation, reflection and feedback. The tools of connectivity allow us to create effective learning environments.

Technology-based learning need no longer be a solitary experience; indeed the relative anonymity has been shown to encourage shy students to participate more than they would in a classroom environment. It is this word environment which is the key. Albert Einstein once said: "I never teach my students anything. I simply create an environment in which they can learn". People may be able to download learning content but they need an environment in which to learn. These requirements are met by software systems called virtual learning environments (VLE), such as the examples offered by Lotus (Learning Space), Saba, Docent and Web CT.

The overall goal of a VLE, from a teaching perspective rather than an economic or logistical one is, according to Harasim, Calvert & Groeneboer (1996), to provide a framework to support active learning, collaboration, multiple perspectives and knowledge building. The tools of connectivity can be seen therefore to allow for the creation of effective learning environments.

7.1.2 Connections to organisational processes

The eLearning industry now offers many different software systems called 'Learning Management Systems' (LMS) that allow educational institutions and private companies to track, monitor and manage learning. This has given these organisations a hitherto unobtainable capability to tie in organisational needs to the individual learning needs and activities of employees, students and customers.

LMSs provide highly detailed, customisable reports on individual learners and groups of learners, which are available to teachers, tutors, trainers and management, literally within a few seconds. Examples of related organisational processes and procedures are business planning, student management, sales and financial management, enterprise resource planning and new product/service development and roll out.

7.2 Broadband

Broadband has finally gone 'mainstream' and is being rapidly taken up by huge swathes of the internet community. For the first time ever, a majority of new internet users in some countries are signing up to some flavour of fast internet access instead of dial up access.

Broadband in the context of games-based learning means that learners can find, access/download and use rich games-based learning content extremely quickly. It also means that these games can feature advanced peer-to-peer collaboration and competition-based features to enrich the experience.

7.3 AI and virtual characters

A quick search on the Internet for 'virtual characters' or 'avatar technology' will yield several dozen competing technologies for creating and deploying virtual characters, intelligent agents and chat bots.

There are advantages and disadvantages of each – not least the cost in many cases – however their very existence demonstrates that it is now possible to build in virtual people into eLearning resources who can represent subject matter experts, in-game mentors, colleagues and other stakeholders within a given scenario.

Technology-based learning need not be about accessing information. It can take the form of a complex, multi-faceted, scenario-driven experience where other 'people' form part of the mix.

7.4 3D objects and environments

Deploying 3D on the web has been a somewhat elusive goal until recently mainly as a result of the bandwidth constraints that came with analogue connectivity.

Whilst there is not yet a ubiquitous solution which is easy to use, cost-effective and appropriate for all needs, there are certainly a plethora of solutions that can be adapted and deployed such as Director 3D, Wild Tangent, Second Life, and many other proprietary 3D/game engines which can be used to create 3D worlds, which learners can explore and interact with people and objects for specific learning purposes.

7.5 eLearning Standards

The 'standards' issue in eLearning is a wide and evolving space that is beyond the scope of this paper. What is worth highlighting, however, is that the relentless drive to ensure that anybody's content works in anybody's LMS has had an undeniable effect on the nature of eLearning content and the eLearning experience.

Many CBT resources in the mid 1990s featured a higher degree of interaction and complexity than is provided by eLearning in 2005. This is in spite of the huge advances in what we can now achieve with modern technologies and tools if we really want to.

Standards such as ADLnet's SCORM and IMS have, in my humble opinion, resulted in the 'dumbing down' of technology-based learning.

The rapidly increasing interest in games and simulations for learning is, I believe, partially driven by a reaction to this simplification process and the desire of educators to deliver appropriately engaging experiences to the audiences.

There is work underway, for example at ADLnet, to attempt to define standards for games and simulations. Whether this will be achieved and whether it is even possible remains to be seen.

8.0 Conclusions & predictions

- Byte size chunks

Use games-based learning where it is appropriate not to do everything (i.e. replace an entire face to face or eLearning course. This may or may not be achievable from a learning context, but it is doubtful that it is practical economically especially if the games-based learning creation is undertaken on a bespoke basis.

- Repurpose and reuse

A key mantra: design games-based learning so that it can be easily modified for an alternative learning purpose/audience or so that it can be updated as the underlying drivers for the learning or the subject matter change....because they will!

- Don't replace the teachers...enable them

Games-based learning in education settings should be to enable the teacher to concentrate on supporting the learning through individualised one-to-one support, coaching, feedback and reflection. The games are not there to replace the teacher but to allow him/her to teach more effectively.

- Home-based learning is a different beast

In home settings games-based learning will need to be less prescriptive, more adaptive and open-ended or learners will switch to the pure entertainment-orientated games.

- Remember the economics

In training and education small budgets need to go further. Cost savings and/or efficiency improvements will be a major factor in the adoption of games-based learning. This will necessitate browser-based approaches and/or 'middleware' solutions.

- Don't try to compete with entertainment games on quality

It is not essential to mimic Half Life 2 (a current example of high fidelity in entertainment games) when creating a game to teach people, for example, business skills. Your audience may be aware of what is possible on a XBOX when it comes to entertainment games but when it comes to training or education they are also comparing what you provide with what they have previously been exposed to in schools, colleges and training centres.

- Skills required / development cycle

Just as was the case with desktop publishing, corporate video production and web site design, many large organisations will attempt to design and develop in-house. Custom games development is complex, requires many different competencies and is best left to those that specialise in its development.

- Cost issues/market forces

If a games-based learning solution costs 6 or even 7 figures then it needs to achieve a pretty hefty ROI or ship a huge numbers of units to break even.

This suggests that only the top of the food chain (e.g. military, large multi-nationals, government) will be able to afford to commission large-scale high fidelity solutions. Likewise the economically-impaired (Schools, SMEs etc) may have to make do with COTS (commercial off the shelf games) to satisfy their learning needs.

In between are organisations that can leverage reasonable budgets that still will not be big enough for the commissioning of a wide variety of customised high fidelity games-based solutions. This section of the market place is where there is most scope for middleware-driven solutions.

9.0 Bibliography, Useful Links & Contact Details

For a huge and frequently updated resource on games-based learning please visit:

www.pixelearning.com/serious_games-resources.htm

Company Biography:

PIXELearning specialise in the design and development of games and simulation-based eLearning solutions (a.k.a 'Serious Games') to deliver deep learning experiences which are engaging, effective and authentic.

Historically, game and simulation development has been time consuming and complex.

It is for these reasons that we have developed our own game engine technology to enable the rapid and cost-effective creation of Serious Games for business and management training and education.

The 'Serious Games' solutions which we provide do not simply deliver information to learners. They provide realistic, detailed simulations of environments, scenarios and events that aid learners to build a deep understanding of the subject matter at hand.

PIXELearning can enable your learners to become 'virtual veterans' and to quickly apply their new knowledge and skills within your organisation to achieve bottom line results.

If you would like to try an example of one of our recent business simulations, or to trial others that we have created, then please visit our website or contact us:

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