Games in Schools

Executive Summary

Purpose of this Report

This report contains a literature review that was completed as part of Work Package 2 of the ISFE-EUN Partnership work plan – Games in Schools.

Specifically, *"to analyse the use of video games as a educational tool, drawing upon existing research, with the aim of identifying how to build up young people's key competence of digital literacy (more critical and responsible in their video games use)"* and to identify the state of educational gaming in schools.

Examples of games utilised have been highlighted from the literature, and frameworks for using Game-Based Learning (GBL) have been discussed.

Key Findings from the Literature review

Skills, knowledge, and attitudes can be improved by means of Game-Based Learning (GBL) given the right environment. Research into using games for learning to support these claims has been carried out over the past 20 years, but with very mixed results. However, the choice of game along with the situated environment and the teachers role as moderator, are vital if the desired learning outcomes are to be achieved. Video games can supplement traditional learning but not replace it. But where the majority of today's teachers are willing to incorporate GBL into their lesson plans, the knowledge and skill level required to implement this technology successfully is lacking. For GBL to be included in the academic curriculum, the issue of teacher support needs to be addressed on a wide scale.

Over the past decade, teacher's attitudes towards the utilization of games for learning have changed. Whereas historically games were not seen to be of value, academic institutions worldwide are looking towards this technology to advance learning. Unfortunately, many of today's students do not see the value of game-based learning. The younger student will enjoy the interaction without categorizing it as learning and the older student will often view games as a non-serious activity within the classroom.

Report by
Maja & Paul Pivec

Summarized Results from Examples

Where the computer game is used in the classroom for research, it will often be an educational game specifically developed for the purpose, and often by the researcher. Where a game is utilized as part of a lesson, it will tend to be a commercial-off-the-shelf (COTS), and often a recreational game, or a commercial game that has been modified for the desired learning outcome.

Students today are critical of educational games as the expected quality of a commercial recreational game is missing. Modifying commercial games has become popular to avoid this, as has allowing the student to design their own game – either to concept level or a prototype if resources allow.

As games can extend outside the classroom, they provide an ideal platform for study aids and to assist with learning impairments. The medical profession has been quicker on the uptake of this technology than has academia and examples have been documented in this report.

Issues for using Game-Based Learning

Although video games have been around for nearly 40 years, and GBL has been researched for over 20 years, the uptake of this technology in the classroom has been slow. The major barrier has been and still is, a lack of knowledge in how to use the resource. Teachers are trained in traditional methods that do not include the use of games in the curriculum. It appears to be researchers and a few innovative teachers that have successfully embraced GBL, although many others are willing to do so given the correct resource and assistance to do so.

Studies show that unless the correct game is chosen for the selected topic, and appropriate moderation and debriefing by the teacher is forthcoming, the desired learning outcome, be it skill based, knowledge base, or affective, they will not be achieved.

Other issues for consideration include technical requirements, licensing policies, sustainability, and more. Video games are an untapped resource in the field of education and will remain so until adequate teacher resource is provided.

Details of this Report

This report summarizes the available literature in the field of game-based learning and specifically how it relates to teaching in the classroom. A critical analysis of some of these studies has also been provided in section 1, including a summary of the methodologies employed. Section 1 also discusses the benefits and perceived problems associated with video games, with section 2 providing specific examples of the use of game-based learning within the curriculum.

To conclude, section 3 analyses the characteristics of video games and suggests how this method of teaching can support the learning process. A complete reference section is included as well as a glossary of game terminology and some suggest resources.

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Introduction

In 2006 one of the biggest European e-learning conferences, Online Educa in Berlin, introduced a special game track. The two-day session hosted an open discussion between academics, teachers and industry practitioners, focusing on the potential of game-based learning in Universities and lifelong learning institutions and possible software solutions. The discussions are primarily focused on Pros and Cons of the application of games for learning, trying to find answers to "*Why don't we use games more often in classrooms?"*

Often it is pointed at the difficulty to find games that cover the curricular topics, the low tolerance of the environment towards the games where the games are often perceived as unserious activity, with some lecturers fearing that the learning objectives wouldn't be reached, and others might encounter difficulties with technical resources that schools don't have. In 2007, games track remained one of the most popular at the Online Educa. It is observed that games for learning are getting increasing publicity and that they are increasingly perceived also as a learning resource.

"Research into using games for learning has been carried out over the past 20 years, but with very mixed results."

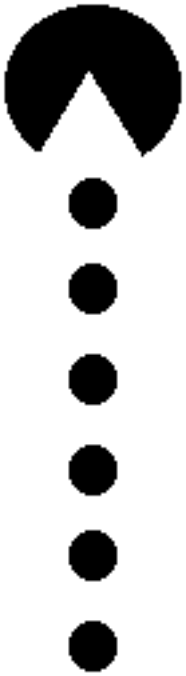
Educators and researchers have long been suggesting that video games have the potential to enhance learning (Malone, 1981; Ramsberger et al., 1983; Malone & Lepper, 1987; Donchin, 1989; Thomas & Macredie, 1994; Ruben, 1999). Many state that the characteristics of some video games create an immersive environment, focusing the player's attention and potentially increasing the uptake of knowledge (MacMahan, 2003; Paras & Bizzocchi, 2005; Gentile, 2005; Kearney, 2006). But what is generally accepted, is that video games can provide the motivation necessary to invoke a persistent re-engagement by the player, thereby improving the chances of the desired learning outcomes to occur (Garris, Ahlers, & Driskell, 2002; Kearney & Pivec, 2007a).

Several major reports that have been commissioned on the topic of educational games (Entertainment and Leisure Software Publishers Association, 2006; Federation of American Scientists, 2006; Facer, Ulicsak, & Sandford, 2007; Project Tomorrow, 2008) have suggested that video games teach skills that relate to education and these skills transfer to business They call for educational institutions to embrace the games community.

"Revamp old pedagogy to take advantage of these new educational tools" (Federation of American Scientists, 2006, p.10).

These reports cite publications such as Menn (1993), who argues that only 50% of what is watched is learnt, 90% of what is experienced is mastered, and Prensky (2006), who suggests that students will soon be teaching themselves. Levy and Murnane (2004) suggests that although schools focus on topics such as math and literacy, soft skills like communication, collaboration, and problem solving are not taught and these are skills that industry requires. Klopfer (2008) advocates education games as a method for teaching soft skills by allowing the students to experience learning through role-play and games. This teaching methodology is known as constructivism and Game-Based Learning is situated in the constructivist arena. Research into using games for learning to support these claims has been carried out over the past 20 years, but with very mixed results.

Related studies and Literature on Video Games as an Education Tool



Research into Game-Based Learning (GBL) as an educational resource has been available since the 1980s. Many believe that GBL provides benefits for most teaching applications, given the appropriate funding and acceptance. The Entertainment and Leisure Software Publishers Association (2006) suggest that this belief has grown from the desire to make learning fun and the opinion that video games are "a powerful learning tool" (p.14). Much of this belief has been spawned from the notion that today's students are "Digital Natives", having grown up in a digital world. This concept has been attributed to Marc Prensky, one of the most widely cited authors in digital game-based learning (Prensky, 2001b), yet many suggest that not only are Prensky's theories severely flawed, but the term Digital Natives was in use prior to his publications (McKenzie , 2007; Seimens, 2007; Bennett, Maton,& Kervin, 2008). In fact, after a thorough analysis of the majority of Prensky's publications, it is viewed that they are mainly opinion papers, not peer-reviewed studies, and offer very little empirical research to support the claims.

Several literature resources support the application of technology as a learning tool and also game-based learning, yet refute the belief that this is because children grow up in a digital world as suggested by Prensky (2001a), Gee (2003), Squire (2004), Shaffer (2006), and others. Take for an example the "Hole in the wall" project (Mitra & Rana, 2001). Computers were setup across India in locations that have never seen any type of technology before. No training or tuition of any type was provided, yet these children were surfing the Internet within hours, downloading movies, using drawing software, playing video games, and even taught themselves how to cut, paste, and save their files. They collaborated with each other and worked in groups, they formed social groupings, and became highly motivated to continue to use this new introduced technology, all without supervision - all of the attributes Prensky and others suggests are only present in children that he calls digital natives.

Mitgutsch (2007) argues that it is neither the computer game nor the technology that promotes learning, but the play surrounding it. He also refutes the term Digital Game-Based Learning in favor of Digital Play-Based Learning. He suggests that the learning occurs in a non-linear unstructured way when technology or video games are used as a teaching tool, and it is often the environment that fosters the uptake of knowledge and understanding. Although the salient points in his publication appear valid, for the purpose of this document the term Game-Based Learning (GBL) will be used, referring to application of digital games for learning as well as role play.

"The desire to make learning fun and the opinion that video games are a powerful learning tool."

The following section's of this report contain a literature review summarizing the major peer-reviewed studies published in the field of Video games for Education and relates them to Game-Based Learning. A balance view has been attempted, however many publications appear to be biased towards video games and methodologies employed are often less than rigorous (Egenfeldt-Nielsen, 2007). Many studies did not use a control group nor did they compare other forms of teaching and learning as alternatives. It is also difficult to assess if the employment of the computer game has assisted in the learning process or it was just that the students embraced the technology as found in the Mitra and Rana studies (2001).

Instructional Design and Learning from Video Games

Ko (2002) explored a framework for studying the patterns children follow to solve puzzles in a computer game. Using a memory puzzle game called *Find the Flamingo,* Ko enlisted 32 children age seven, and 55 children age ten. Ko measured the children's technique for problem solving by counting moves and assessing the pattern of these moves. Ko did this using a board version of the game as well as a computer version. Among the findings, Ko notes that the children appeared more motivated to use technology and play the computer version rather than the board version. Ko also noted that the more times that the children played the game, the greater their understanding of the construction of the game and the inferences within the game-play. The group of ten-year-olds performed better overall than the seven-year-olds in the results; with the ten-year-olds requiring fewer moves to complete the game. Ko concluded that this study shows that children can problem solve by gaining inferences from the game itself, and, by using these hints, apply reasoned decision making to increase their performance. But, does the design of the game influence the child's playing behaviour? – Ko says yes, and suggests that educators must consider this when choosing games as part of a learning curriculum.

Curtis and Lawson (2002) wanted to ascertain if problem solving performance could be improved by playing video games, rather than the game just influencing how the player's ability is used. Curtis and Lawson note that there are two theories as to how problems are resolved: using gained knowledge or using strategy. They developed an adventure game titled *The Ancient Abbey,* where the player is required to search for objects in various locations. Recruiting 40 participants between the age of 12 and 15, the researchers recorded and transcribed the player's verbal commentary during the game. The player's paths through the locations within the game were also recorded and later examined using PLS path analysis (Partial Least Squares – a method for developing a predictive model). Curtis and Lawson's results were inconclusive. While their statistical analysis showed that the players developed strategies and applied these in problem solving, there was no evidence to show that this skill would carry over to tasks outside of this game; they did not show that cognitive ability was increased except within the confines of this game. However, they did find that increasing the complexity of the game increased the cognitive load on the player, but when the player developed knowledge based on the game, this load was reduced.

"The design of the game influences the child's playing behaviour and educators must consider this when choosing games as part of a learning curriculum."

Pillay (2003) conducted a similar study with 36 students between the age of 14 and 16. He maintained that although their knowledge was significant, an analysis of the strategy process and how it affects performance was needed. The participants were divided into groups and each group was given either educational puzzle games or recreational strategy games. He used a mixed method design adopting both a quasi-experimental design and an adaptation of the PARI analysis (Precursor, Action, Result, and Interpretations). Pillay found that the recreational games facilitated learning more than the educational ones. He suggested that the game players reasoned more effectively and employed anticipatory thinking. He reinforced Ko's (2002) findings, suggesting that the students were able to learn by gaining inferences from the games design.

Egenfeldt-Nielsen (2005) explored the framework in which video games could be used within a classroom environment. His research involved the participation of 72 high school students and their teachers over a period of 10 weeks. Using a commercial historical strategy game, *"Europa Universalis II",* his results suggested a difficulty in relating the lessons learnt within the game to the desired learning outcomes and concludes with a suggested framework for overcoming these issues. Suggestions such as using games to build on existing knowledge or experimenting within a safe virtual environment, point to video games being used in addition to traditional lessons and not as a replacement.

"Young people often perceive the use of games for education as an un-serious activity,."

Zagal, Rick, and Hsi (2006) also used board games in their research and concluded by comparing the collaborative design of *"The Lord of the Rings"* with popular multiplayer video games such as *"Battlefield 1942"*. They concluded that although games that foster collaboration between the players are difficult to design, they provide a unique potential to foster such activities as teamwork, collaborative problem solving and decision-making, and responsibilities within the group. They go further to state that video games are uniquely positioned to overcome some of the pitfalls of board games by utilizing well defined instructional design and communication support features. Moreover, with some unstructured online multiplayer games providing such player freedom, they suggested that players are forced to collaborate and create their own rules to progress through the game.

Pannese and Carlesi (2007) looked at games within the classroom environment and compared the use of games for training within Universities and Industry. They observed that while computer technolgy provides a valuable resource and if structured correctly, a computer game will immerse the participant in the learning. Younger people are more critcal about the use of games and the game itself. With many students being exposed to commercial games everyday and the PISA (2006) survey of OECD countries states that almost all 15 year old students are comfortable with using this technology, young people often perceive the use of games for education as an un-serious activity, as shown in a survey of 160 university students by Pivec and Kearney (2007).

Kovalik and Kovalik (2008) studied player collaboration within simple games and found that lessons of everyday life could be learnt. In their study they divided participants into groups to play card games with rules, without rules, and with non-specific rules. Their results suggested that the students were willing to accept the rules of the games, and where there were none, they imposed their own. During the debriefing with the students, they discussed similarities between the rules of society and having rules within a game. They found that their students were subsequently willing to accept the need for rules within an organized society; for without these rules, chaos can occur as it did in the games without any rules or with non-specific ones.

Perceived Effects from Playing Video games

With much of the literature having opposing views as to which attributes educational and commercial game designers should focus on, critics often turn to discussing what effect these games have on the children playing them. Subrahmanyam, Kraut, Greenfield and Gross (2000) discuss the literature available regarding the impact of computers and video games on a child's development, but state that the findings of these studies are only suggestive with very little empirical data being offered. The studies they include ranged from very small sample sizes to over 500 participants. They cite several papers that suggest links between inactivity, playing video games and child obesity, and promote the view that first-person shooter games lead to aggressive behaviour. They also discuss the question of increased academic performance through playing games and argue that there is no systematic research nor emperical studies to support any firm conclusion.

However, Stevens (2000) studied 33 students ranging in age from seven to 14. These students played games for one hour each morning, for 30 visits. The researchers also used a control group of 37 students who completed the same tests without playing the games, however no alternative teaching method such as drill and practice was offered. Stevens notes that parents of the participants who played the games not only reported improvements in school work, but also in other skills like a sense of direction, increased interest in literature, and an increased patience with daily tasks. This suggests that Dorval and Pepin (1986) were correct and video games can improve visual and spatial skills resulting in higher academic achievements.

In a qualitative study of 500 children in New Zealand between the ages of five and ten, Wylie (2001) found that television impacted adversely on children's reading where computers games did not. She also observed that children's visual skills were increased from playing video games and maintains that no adverse social effects are seen when playing moderate amounts of games, but notes that other researchers claim that aggression is linked to excessive playing time i.e. more than thirty hours per week.

In a study completed by Attewell, Suazo-Garcia, and Battle (2003) with 1,680 school children in the UK between the ages of four and 13, some tangible results were offered. They included social aspects, such as self-esteem and obesity, as well as performance factors like abilities in academic competence. The results of their study showed that children who used computers not only scored significantly higher on cognitive tests, but also spent more time reading books than those who did not use a computer. However, the difficult question is not answered of whether or not children who read more and have higher cognitive abilities are naturally attracted to computers. Attewell et al. noted that computer users also scored higher in the self-esteem tests, but this was only for children that used a computer for less than eight hours per week. Children that used a computer for more than eight hours tended to suffer from obesity and had low self-esteem, possibly as a result of the weight problem. Interestingly, they also found that television had a detrimental effect on outdoor activities, where as computer usage did not, thus supporting the finding of Wylie (2001). Attewell et al. concluded that modest use of computers by children was significantly beneficial, both socially and academically. They highlighted that the majority of the children's computer usage was for playing video games.

"No adverse social effects are seen when playing moderate amounts of games."

Kearney (2005) found that the playing of recreational games, such as the first-person shooters (FPS) *"Counter Strike*", for up to eight hours per week increased multi-tasking abilities. Kearney's research showed that those who played for up to eight hours per week had significantly higher scores on multi-tasking tests than those who did not play at all. However, participants who played for longer periods of time did not score significantly higher than those who did not play at all. This implies that eight hours per week is an optimum time for playing games to improve cognitive skills without the negative affects observed by Attewell, Suazo-Garcia, and Battle (2003).

"Sex and violence in videogames is a social issue that confronts us all, yet as society we are inconsistent."

Blake (2008) comments on the growing issue to ban video games. With FPS games such as *"Counter Strike*" and the age restricted game *"Grand Theft Auto IV"* being played by tens of millions of players around the globe, politicians, administrators, and other critics, argue that "killing police officers and directing pornography is bad for kids, and therefore playing video games is bad for kids" (p. 3). Playing violent video games appears to be on the rise with the players themselves finding no validity of the transference of violence to the real world. In fact, many of the studies included in this review were conducted using FPS games. Sex and violence in videogames is a social issue that confronts us all, yet as society we are inconsistent.

"Anyone who plays the game will end up doing in the real world exactly what they do in the virtual world" (Blake, 2008, p.1).

We condemn violent videogames and sexual content, yet at the same time we are condoning them and utilizing them when convenient (Kearney & Pivec, 2007c). Hence, the issue of violent and sexual content in video games, and if the perceived aggression transfers outside of the gaming environment, is outside the scope of this report because most of the literature discussing this facet of video games is purely opinion and often emotive.

The Use of Game-Based Learning for Academic Achievement

Wainess (2007) advocates that games do not foster learning at all, cognitive skills nor knowledge acquisition, and it is purely the context in which they are used that stimulates any learning to take place. Garris et. al. (2002) argue that learning occurs only after reflection and debriefing, and the game characteristics and instructional content are paramount in allowing this to happen. Shaffer (2006) partially agrees and states that the virtual worlds created by such games allow students to take action within the game and then reflect on this action, both during and after play. Many of these learning models differ, and with the use of video games for education becoming more popular, the issue of teacher education in the area of how to use video games and how they will achieve the learning outcomes still needs to be addressed.

A poll conducted by FutureLab (Facer, Ulicsak, & Sandford, 2007) in 2005/6 of 2,334 secondary school students in the United Kingdom found that 59% of teachers would be willing to use game-based learning and 62% of students would welcome it. A similar poll released on April 8th in the United States (Project Tomorrow, 2008) of 319,233 students across 3,729 schools, 65% of teachers were interested in the use of games in the classroom. Neither of the surveys reported a widespread use of game-based learning in schools within the UK nor the US, and the literature reviewed for this report suggests that video games are introduced into the classroom often for the purpose of research.

"65% of teachers were interested in the use of games in the classroom.."

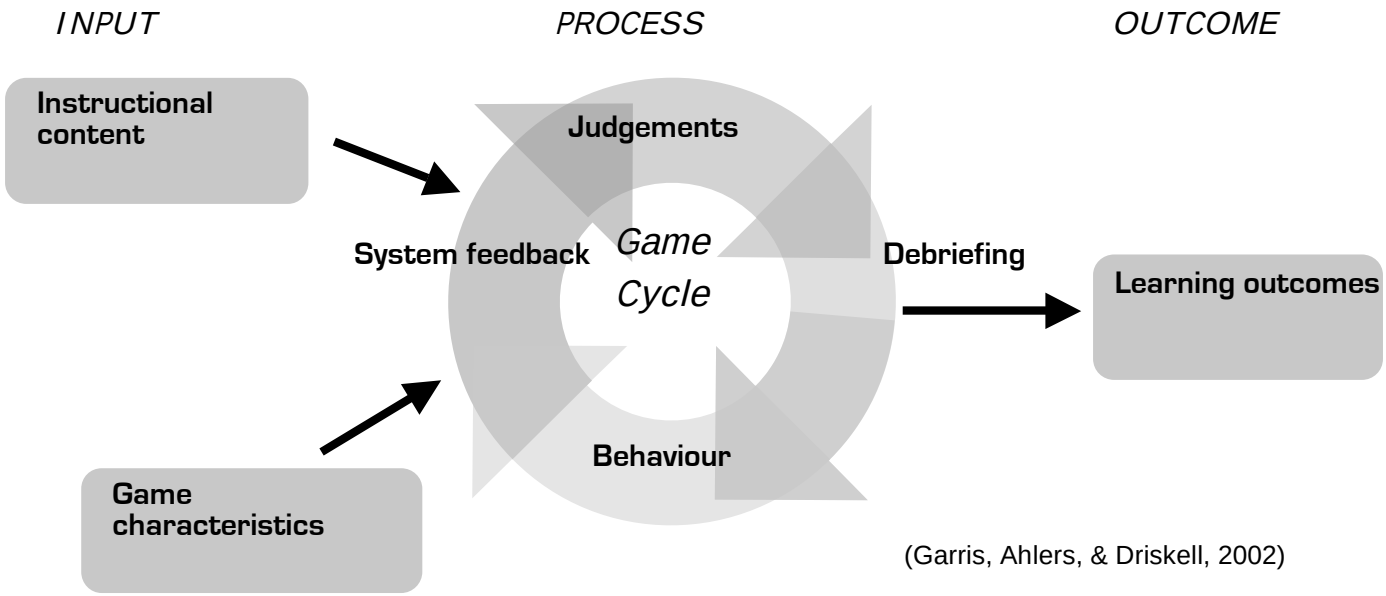
One of the main barriers to the introduction of video games into the curriculum is the ability of the teacher to integrate the game into the topic. Egenfeldt-Nielsen (2006) concludes that the role of the teacher is crucial in achieving the learning outcomes from GBL, be it declarative or affective. Cramer, Ramachandran, and Viera (2004) agree with this and suggest that although the future of learning revolves around 3-dimensional environments that inherently promote learning, such as Active Worlds, the ability to utilize such tools is an issue for teachers. Dickey (2003) investigated a constructive learning approach using the 3-dimensional application Active Worlds. He suggested that the environment fostered a high level of peer support with the results showing collaboration between students, social negotiation and peer mentoring (affective learning). However, he concludes by suggesting that software influences the learning dynamics but does not create them and suggests that further research is needed to ascertain how products like video games can be used more effectively in a learning environment.

Commercial video games are known for creating social environments and cult followings surrounding the game play, the character attributes, and player's abilities, and this is where affective learning and social skills can occur.

"Affective learning includes feelings of confidence, self-efficacy, attitudes, preferences, and dispositions" (Garris et al., 2002, p.457).

Both surveys (Facer, Ulicsak, & Sandford, 2007; Project Tomorrow, 2008) suggested a difference in the perceived learning outcomes of GBL. Teachers and students believed that computer skills are enhanced by utilizing games in the classroom, but where the teachers perceive the value to be in the uptake of declarative knowledge, the students believe the value is more affective learning, ie: social skills.

Garris et al. (2002) agree with the students and suggest that a substantial part of the learning is achieved outside of the game cycle during reflection and debriefing (*figure 1*).



(Garris, Ahlers, & Driskell, 2002)

Figure 1:
Learning in GBL

Kolb (1984) states that learning follows a cyclic pattern, and the reflection on experience is part of the learning cycle itself *(figure 2),* similar to Shaffer's reflection-in-action. However, Paras & Bizzocchi (2005) argue that when play is broken up with reflection, the learning is reduced. But if the reflection is dispersed within the game by the design of the game, the learner/player takes responsibility for the learning outcomes.

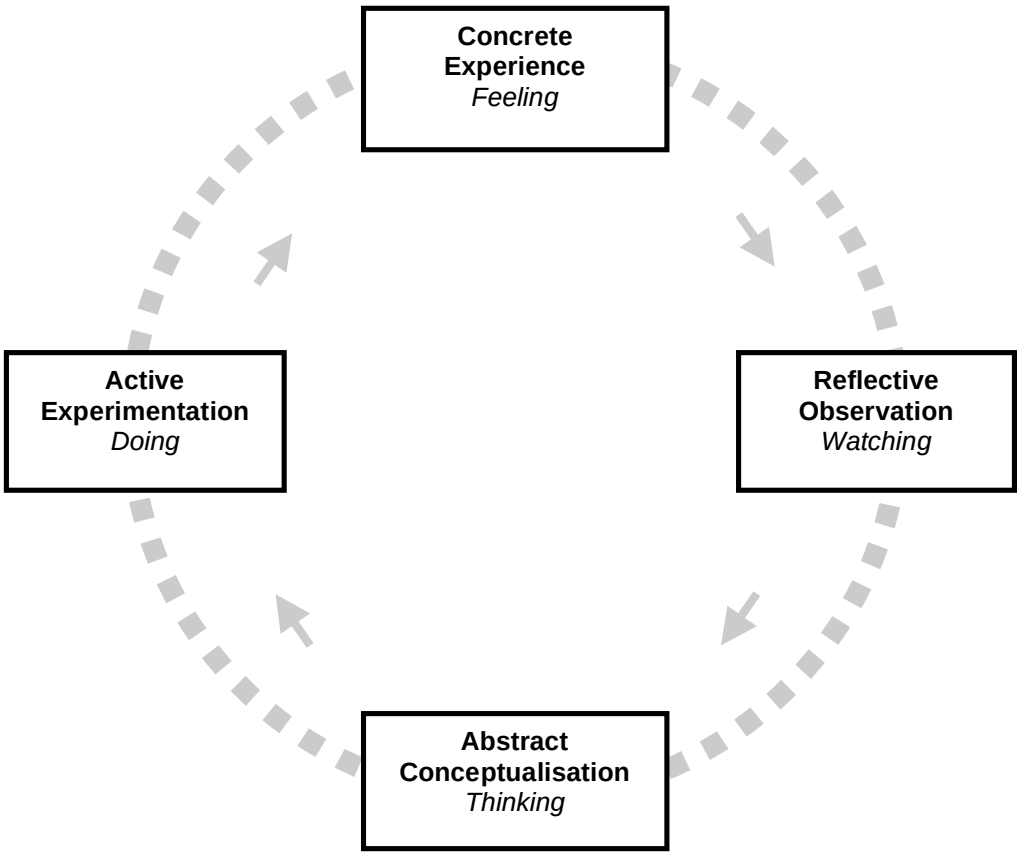


Figure 2:
Kolb's learning styles

Video games can foster skill based, knowledge based, and affective learning. Referring to the model of Game-Based Learning *(Figure 3)*, we can suggest where the different types of learning occur by means of the macro and micro game cycles, and include the player reflection within the game, during play and between levels. The skill-based learning appears to comfortably fit within the micro game cycle or levels within the game. For example, Rosser et al., (2007) found that the playing of commercial action games improved the surgical skills of laparoscopic physicians and decreased their error rate. There was no documented debriefing session for Rosser's study and it is assumed that the development of technical or motor skills occurs within the game itself.

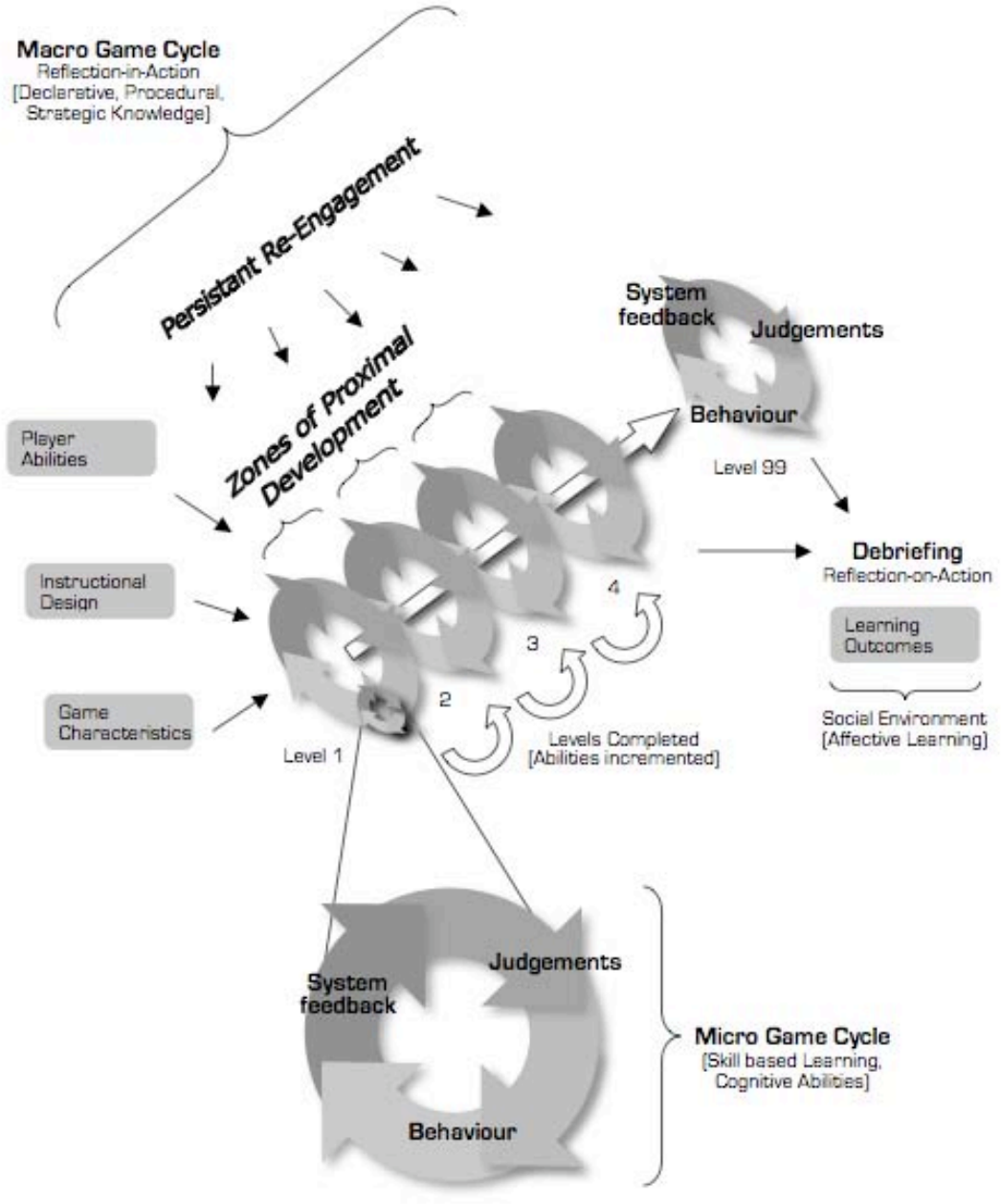


Figure 3:
Recursive loops of Game-Based Learning (Kearney & Pivec, 2007a)

Knowledge based skills are defined within this model as declarative, procedural, strategic knowledge. Declarative knowledge being facts and data that are required to complete a task or to perform well within the task and these would be provided by the game or system feedback. Procedural knowledge is required to know how to approach the task and subsequently complete it. This could be referred to as knowing how to apply the declarative knowledge to a given situation. Strategic knowledge is the reasoning behind the task and how the task could be achieved in a different or more creative way. Each of these skills is achieved through reflection, but with many fast action video games, it is reflection-in-action and occurs throughout the game cycle and within each level. As skills and abilities are attained, the player advances through the game and increments their knowledge. Players often do this without being aware of the process and this is where the teacher, as moderator, can highlight the meta-cognitive skills utilized. However, both the above-mentioned surveys found that there is a generation gap of technical knowledge with teachers rarely playing or even having knowledge about video games and the students being well versed in the technology.

"As skills and abilities are attained, the player advances through the game and increments their knowledge."

Outline of Available Research in the use of Game-Based Learning

Research into the use of video games for learning has produced inconclusive and contradictory results. Many publications focus on the negative effects of recreational video games (Gibbs & Roche, 1999; Anderson & Dill, 2000; Rollings & Morris, 2000), and many can be found to suggest the positive side in the learning effects provided by Game-Based Learning. Druckman (1995) suggests that these learning effects are purely as a result of the effective motivation created by playing recreational games and supports Malone's (1981) theory; that the intrinsic motivation and the challenge created by video games is what improves the uptake of knowledge. Others state that the drill and practice opportunity provided by video games improves learning (Wartella, 2002; Clark, 2004), yet some debate that there is no substancial proof that players learn from such games (Subrahmanyam et al., 2000), or that skills learnt from video games are transferred outside of this domain (Egenfeldt-Nielsen, 2005).

The research that refutes the learning attributes of video games is often qualitative, and merely a survey of available literature, as is the case of Subrahmanyam et al., (2000). Other research shows that skills are learnt, and retained, and can be transferred to other areas of life (Pillay et al., 1999; Stevens, 2000; Fullam et al., 2001; Rosser et al., 2007). Some research also contradicts another, as in the earlier study by Egenfeldt-Nielsen's (2003) where he stated that eye-hand coordination was not improved when playing a popular arcade game title "*Super Monkey Ball*". However, in a recent study by Rosser et al., (2007) using the same game, eye-hand co-ordination was not only found to be improved, but also transferred outside the context of computer game play. This indicates that research in the area of GBL is varied and results differ as widely as the methodologies employed, as well as in the context of the usage of video games.

"Some debate that there is no substancial proof that players learn from such games."

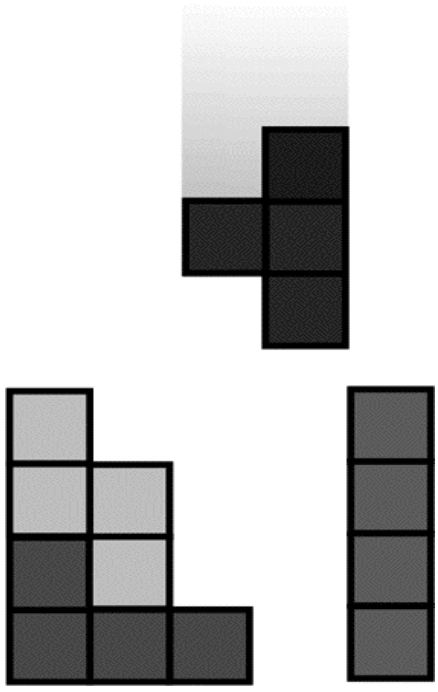
For the purpose of this report, 42 major studies in the field of Game-Based Learning (GBL) over the past 20 years were reviewed. Many of the studies reviewed are also referenced in research on GBL by Beazzant (1999), Prensky (2001), Brown (2002), Gee (2004), Buchanan (2004), Oblinger (2004), Egenfeldt-Nielsen (2005), and others. The studies applied a wide variety of various methodologies, from quantitative experimental approaches applied in early studies, to appearance of various qualitative approaches from 2000 on, to various mixed approaches observed from 2003 on. The following table (Table 1), elaborates on extracted data from the above research studies, identifies the methodologies employed by each of the studies, classifies them and clearly shows a trend from quantitative experimental design towards a mixed methodology.

However, as suggested by Egenfeldt-Nielsen (2007), many of these studies do not adhere to rigorous academic research standards. He concludes with the fact that most research into education with video games does not compare results with the traditional or even alternative teaching methods.

"Many of the studies have severe flaws related to researcher bias, short exposure time, no control group and lack intergration of previous research" (Egenfeldt-Nielsen, 2007, p. 268).

Some studies have attempted a research methodology, as in Betz (1995) and Adams (1998), yet even with a control group of students employed, the experimental group exposed to the games on the topic being taught, had more exposure to the topic as in Stevens (2000) mentioned earlier; hence it could be argued that these students scored higher merely through more time on the subject.

Likewise, with the more recent studies of Rosser et al., (2007), where laprascopic surgeons improved their skills play "*Super Monkey Ball*", and Korczyn et al., (2007), where "*Tetris*" type games were used to treat degenerative diseases such as Alzheimer's, control group participants did not embark in any other forms of training and hence spent less time on the topic. It could therefore be aurged that video games are merely an alternative form of Drill and Practice methodology.



"It could be argued that these students scored higher merely through more time on the subject.."

Table 1: **Methodologies in GBL Research**	**Quantitative**	Experimental	Quasi-experiment	Correlation	**Qualitative**	Ethnography	Grounded Theory	Case Studies	Phenomenon	Narrative	**Methods**
Dorval & Pepin (1986)	■	▒									
Dowey (1987)	■	▒									
McMullen (1987)	■	▒		▒							
Redd et al., (1987)	■	▒									
Okagaki & Frensch (1994)	■	▒									
Wiebe & Martin (1994)	■	▒									
Betz (1995)	■		▒								
Dolittle (1995)	■			▒							
De Lisi & Cammarano (1996)	■	▒									
Thomas et al. (1997)	■	▒									
Brown et al. (1997)	■	▒									
Klawe (1998)	■	▒									
Adams (1998)	■			▒							
Pillay et al., (1999)	■			▒							
Feng & Caleo (2000)	■	▒									
Hill & Agnew (2000)	■	▒									
Noble et al. (2000)	■	▒									
Stevens (2000)	■	▒									
Subrahmanyam et al., (2000)					■		▒				
Turnin et al., (2000)	■	▒									
Fullam et al., (2001)	■	▒									
Wylie (2001)					■	▒					
Nova (2001)					■	▒					
Gander (2002)	■	▒									
Ko (2002)	■	▒									
Curtis & Lawson (2002)					■				▒		
Wartella (2002)					■		▒				
Atwell et al., (2003)					■		▒				
Joyner and TerKeurst (2003)					■	▒					
Moore (2003)	■	▒									
Green and Bavelier (2003)	■	▒									
Antonietti & Mellone (2003)		▒					▒				■
De Castell & Jensen (2003)			▒							▒	■
Pillay (2003)			▒			▒					■
Rosas (2003)	■	▒									
Squire et al. (2004)			▒							▒	■
Sweetser & Wyeth (2005)				▒			▒				■
Kearney (2005)			▒				▒				■
Buch & Egenfedt-Nielsen (2006)		▒					▒				■
Shaffer (2006)				▒				▒			■
Rosser et al., (2007)			▒					▒			■
Korczyn et al., (2007)		▒						▒			■

Examples of Video Games as an Education Tool

Educational games that have been accepted into the curriculum are not common. Many have been developed by the teacher with limited funding and technical skills, and often do not captivate the students. Ferdig (2007) suggests that most game developers and software publishers do not allocate money or resources to educational products believing that such ventures are not profitable. The Federation of American Scientists (2006) agrees and states that most high-end computer and console games will cost anywhere between US$10 to $25 million and most never recover their development costs.

However, some commercial educational games such as "*Chemicus", "Physikus",* and *"Informaticus",* by Braingame Publishing, have the quality of a recreational game and also include defined learning outcomes. These games employ an interface very similar to the popular commercial adventure game "*Myst"* from UbiSoft, and provide an interactive story to transport the player into an immersive environment. A similar approach was used by students at the University of KwaZulu-Natal in South Africa (Seagram & Amory, 2004) to create a study aid for medical students. Their game immersed the player in narrative and encouraged them to play out the story by solving puzzles using prior knowledge of DNA.

Reese (2007) suggests that video games and virtual worlds create player immersion (Kearney & Pivec, 2007b) and cites the concept of *flow* from Czikszentmihalyi (1990). Reese advocates that game worlds should be used as a space for learning because of their immersive qualities. However, Calleja (2007) argues that the concept of immersion has been diminished through its widespread use in academic discussions. He promotes a game experience model to incorporate the concepts of immersion and presence, to further the understanding of social significance and personal values of video games. Buckingham and Burn (2007) conclude that this social significance has positive implications in education practice and cite examples where games have been used successfully within the curriculum, including students creating their own games for specific subjects.

"Most high-end computer and console games will cost anywhere between US$10 to $25 million and most never recover their development costs."

Using Video games within Specific Subjects

De Castell and Jenson (2006) created Contagion, a role-playing game fostering interdisciplinary learning and targeted at children aged 10 – 15 (de Castell and Jenson, 2006). The game is based on traditional school subjects and related subject fields like technology, biology and medical sciences, as well as human and social sciences. The goal of the game is twofold. On one hand, the game should introduce health related topics and educate players by means of "serious play" about diseases, such as Severe Acute Respiratory Syndrome (SARS), West Nile Virus (WNV), Avian Flu, and Acquired Immune Deficiency Syndrome (AIDS), and possible preventive behaviours. On the other hand, the game also provides a career preparation environment; where players can learn about and role-play various occupation of interest e.g. community health officer, physician, or a medical researcher. The player entering the game world chooses one of these roles that effect the development of the game play and the point of the view on the situation throughout the game. In the game the player is confronted with the situation of medical and humanitarian crisis, and acts out the situation differently based on the respective role. The majority of the learning is based on active exploration.

The EC funded project group known as "*eCIRCUS*" has developed an approach using GBL to support social and emotional learning. Using virtual role-play with virtual characters they establish credible and empathic relations with their students. The game *"FearNot"* has now been trialed on over 1000 children to test its ability to evoke empathic interactions and affective responses. The narrative-style game improvises dramas to address bullying problems for children aged 8-12 in the UK, Germany and Portugal. The authors (Dias, Paiva, Vala, Aylett, Woods, Zoll, & Hall, 2006) found that nearly 80% of the students emotionally connected with the virtual characters. They conclude by recommending the platform be extended into other areas such as intercultural empathy.

Quest Atlantis (Barab, Thomas, Dodge, Carteaux, and Tuzun, 2005) is a 3-dimensional virtual environment, where a teacher can define various educational tasks in form of quests, thus enabling the adaptation of the game to different educational contexts. After registration on the web site, the environment can be accessed from everywhere by the internet. By completing the quests i.e. educational activities, learners help to save the mythical Atlantis from a disaster. The Quest Atlantis virtual environment consists of different 3-D worlds that foster exploration and enable various social and goal oriented interactions. Babab et al (2005) argues that Quest Atlantis attempts to capture the environment, which motivates players in commercial video games. The environment combines play, role-playing, adventure and learning.

Paul and Hansen (2006) from the University of Minnesota modified the game "*Neverwinter Nights"* to teach journalism. The contents of the textbook "*Behind the message: information strategies for communicators",* which is used in one of the core courses, are transferred into a game. Here, the student acts as a reporter and must decide on the type of story angle they will cover in response to a railroad accident and chemical spill. The aim of this game is that students learn to organise, interact, question and evaluate information from different resources. The game's library is stocked with hundreds of pages of documents and sources from online sites, and *"Harperville",* the town where the game is situated, is populated with dozens of characters who can be interviewed by the students, who play as a rookie reporter. As player moves through the information- seeking process, they take notes in a reporter's notebook within the game. They then compile their story, get a printout of their reporter's notebook, and write a 1,000-word news story with the information they've gathered. The class instructor then assesses their notes to see the type of notes students have taken, and how they used those notes in generating their stories.

"Nearly 80% of the students emotionally connected with the virtual characters."

The Orange County Public School in Florida, utilized the commercial educational game from Tabula Digita (2006). They included the First-Person Shooter (FPS) game *"Dimexian"* as a study aid for Algebra. Teachers were first trained to play the game and facilities were then set up for students to play after lessons had been completed. Dr. Clark, the Principle of the school, reports that students did not perceive it as learning mathematics and eagerly waited for their turn to play. As a result, she stated that not only their problem solving skills improved but also encouraged collaboration between the students. Future plans are now underway to hold tournaments with other schools and teams of players. The instructional design of the game is such that players with better Algebra skills progress quicker than those with gaming skills.

Sorensen and Meyer (2007) reviewed a game-based language course (English as a foreign language) introduce into primary schools in 2006 in Denmark. Using a web-based platform, the game *"Mingoville"* contains 10 missions in which players complete activities focused around vocabulary, spelling, and word recognition. Aimed at children aged 5 to 14 years, the product is written in Adobe Flash and has now been translated into 31 languages. The game centers on a village populated by flamingos and the player completes activities to advance through the game. The subscriber-based product is used within the school and at home, and Sorensen and Meyer recommend that *"Mingoville"* is an excellent example of how Game-Based learning can successfully supplement traditional teaching.

"The role of the teacher as facilitator is paramount to the success of the learning outcomes.."

Also from Denmark, Magnussen (2007) described a role-play game aimed at problem solving. In *"Homicide"* the players are forensic experts attempting to solve a crime. The students play in teams and the teacher acts as the chief of police. Aspects of the game are player on computer with discussions being face-to-face with the students. Magnussen argues that the game is highly engaging for the students but the role of the teacher as facilitator is paramount to the success of the learning outcomes.

"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, 2008, p. 150).

Mayer and Bekebrede (2006) successfully implemented GBL using simulations. Their games titled *"Containers Adrift"*, the planning and design of an inland container terminal, *"Ventum On Line"*, the simulated management of a wind farm, and *"SIM MV2",* the planning of infrastructure for a 2nd port in Rotterdam, are all successfully utilized at the Delft University of Technology. However, the authors suggest that simulation games are not affective in isolation and work best when they are embedded in a well structured education or training program. They agree that teacher guidance or moderation and a debriefing session are critical steps in game-based learning.

Burmester, Burmester, and Reiners (2008) also created simulations of Container Terminals using the virtual environment of Second Life. They suggest that the blended learning approach taken by the University of Hamburg allows for a richer environment for the students and a safer one when teaching Terminal logistics and management. However, they conclude that although the virtual world of Second Life suits their purpose at the present, they have structured their resources as to be able to port them to other virtual worlds in the future.

The Simulations and Games in Education research group from METU (Middle Eastern Technical University in Turkey), School for Educational Technology, used the public domain version of the popular commercial game "Tomb Raider". Levels were modified to require Lara Croft, the heroine of the game, to solve problems using the knowledge of Photosynthesis, Vitamins, and Fat, Protein, and Carbohydrates (Cagiltay, 2006). The game was developed for 5th grade students and is freely available for download.

Rylands (cited in Entertainment and Leisure Software Publishers Association, 2006) used the popular computer game "*Myst*" to develop literacy and descriptive writing skills. By projecting the game on to a whiteboard in the classroom, Ryland discussed sights and sounds within the game in a group environment. The puzzles of the game were solved as a group and the teacher observed an improvement in negotiating skills. Their adventures within the game were also recorded to practice their creative writing skills.

The EU funded project "DISCOVER" (Dondi & Moretti, 2007), also lists examples of successful implementations of game-based learning in classrooms. Specifically, *"Living History"*, a common history web-based book where students can add to like a wiki; *"aVataR@School project"*, a role-play scenario that takes place inside the virtual world of second life.

Designing Games as part of the Curriculum

Video games are often though to provide the motivation necessary to learn. Clark (2004) maintains that commercial game designers are successful because they focus only on engaging the player and making the game fun to play. He states that it is the design of the interactivity that provides the motivation necessary to invoke the persistent re-engagement by the player. This can be achieved at an emotional level or an intellectual level, but for the player to learn from the game, Clark argues that the game design must include action and consequence; learning will then be achieved through reflection.

An educational game design course created by Pivec and Kearney (2007), they asked 75 information design students at the University of Applied Sciences Joanneum in Austria to role-play as commercial game designers. The challenge for students was to create a concept proposal for a publisher of educational games. The class was a role-play itself i.e. game about designing a game, where students had to work in teams, create a game design company and take a specific role and responsibilities within the team e.g. game producer, game developer, programmer, etc. to contribute to the task accomplishment. The course covered topics including the process of commercial game design, taking into consideration the pedagogical design required to achieve the desired learning outcomes. When games are designed for learning, both the target audience and the learning outcomes have to be considered at the initial conception of the game. In this way teachers can easily recognise the value of this resource and the possibilities to include such games in the curriculum. Aspects of educational game design are tackled more in detail in (Pivec, Koubek & Dondi, 2004).

"The majority of the students found the course to be succesful with 70% of the students enjoying the topic."

Students were surveyed both, before and after the completing the course on their opinion on games in general and regarding the potential of application of games for learning. Also surveyed was the motivational momentum of designing a game in terms if they were more motivated and achieved better learning results. Based on this survey Pivec and Kearney (2007) wanted to assess if the students saw educational game development as a possible career path. On the post survey, 66% of the students agreed that designing educational games was a highly motivational topic and suggested that they now felt competent enough to write a professional educational game concept document. They also agreed the designing educational gems could provide future career opportunities, however only 35% of them would consider this for their own career. The majority of the students found the course to be succesful with 70% of the students enjoying the topic despite not considering themselves to be game players. Those who did play video games, only did so for recreation and had not involved games with any of their schooling. However, upon completion of the course, 60% of the students showed a preference for using games to learn.

At the Middle Eastern Technical University in Turkey, software engineering students learn programming by designing and creating a video game prototype. Cagiltay (2007) observed that student abilities are improved in the areas of problem solving and the application of known skills, through constructivist learning. She concluded that student motivation was very high and their performance overall improved when compared to previous years.

Other researchers and teachers have also used game design to motivate learning. Lennon and Coombs (2006) targeted the topic of health, creating a role-play designing a board game about dengue fever. Their results showed that the games created highlighted the knowledge or misconceptions that the child had about the disease. They argue that appropriate instruction and subsequent debriefing by the teacher will increase and reinforce the level of declarative knowledge about the topic. They conclude by recommending the use of game design as an assessment tool for the knowledge of any subject.

Game-Based Learning to offset Learning Impairments

In 1995, Dr. Friedrich Masendorf (1995) published his findings with learning-disabled children. He stated that puzzle games such as Tetris and Blockout improve the spatial abilities critical for learning. These games allow children to expore the geometrical shapes and visualize them from other angles. This research was was confrimed by De Lisi and Cammarano (1996) playing the same puzzle games and spatial visualisation abilities are suggested by Dorval and Pepin (1986) to assist with subjects like maths and science.

"Two-dimensional and three-dimensional spatial abilities can be cultivated in learning-disabled children" (Masendorf, 1995, p.49) .

Unfortunately, today's generation do not play games like Tetris or Block out. They are more captivated by action games, such as First-Person Shooter games (FPS), or Role-Playing (RPG) and Real-Time Strategy (RTS) games; all recreational commercial video games.

In an article by Griffiths (2005), references are made to many uses of video games for rehabilitation. The article cites Redd, Jacobsen, DieTrill, Dermatis, McEvoy, & Holland, (1987) where video games were successfully used to offset the nausea felt by children during chemotherapy. Griffiths suggests that video games may be used in the areas of:

- Treatment of Autism and ADHD
- Spatial and learning disabilities
- Cognitive rehabilitation for young and old.
- Development of social and communication skills.
- Pain management and health care.

In a paper on e-inclusion by Pivec, Dziabenko, & Kearney (2005), a call for innovative research into the use of video games to offset learning disabilities is tabled. Kearney (2006) suggests that the characteristics of many recreational commercial video games create player immersion that will enhance the cognitive effect that is required by the above applications. Klingberg, Forssberg, & Westerberg, (2002) agree and suggest that some games assist the improvement of working memory and this will help children with Attention Deficit disorders, as well as rehabilitation after stroke and traumatic brain injuries. Klingberg et al. are now the scientific advisors for the commercial company "Cogmed" who created and market the game-based learning product *"RoboMemo"* – a computer program designed to assist the improvement of work memory. *"RoboMemo"* is based on the same theories as Nintendo's *"Train your Brain"* games. The object of these games is to repeat back the numbers of images shown on the screen or letters and numbers sounded, in the same order or reverse order. As with the Doman's (1986) theory of repetition, CogMed suggest that the participant uses *"RoboMemo"* for 30 minutes per day, for five weeks. At the end of this period, the company reports that 80% of participants not only have increase attention span, but also report an increase in academic achievements (although not quantified) due to an increase in working memory.

"Many recreational commercial video games create player immersion that will enhance the cognitive effect."

Doman (1986) argues that "how well we learn is a direct reflection of how well we receive, process, store and utilize information", all functions of working memory. Jaquith (1996) suggests that a one-digit increase in score from Digit Span Forward tests (a widely accepted test of working memory capacity) correlates to a significant increase in academic achievement, specifically an improvement in an individual's academic function relative to their suggested grade level. Jaquith shows a direct correlation between the results of Digit Span tests and academic test scores; the greater the working memory capacity, the high the academic test scores. Students that had participated in the Stanford Achievement Test (SAT) for Total Reading, Math, Listening, Thinking, Word Reading, Language, Letters/Sounds, and Spelling, had their scores compared with their Digit Span test scores (Auditory and Visual tests).

"If one improves one's auditory and visual digit span, and thus auditory and visual processing, the individual's academic function relative to grade level will improve" (Jaquith, 1996, p. 1).

The improvement cognitive abilities such as working memory can also be applied to offset learning disabilities from degenerative diseases like Alzheimer's, and learning impairments resulting from problems such as ADHD and Late Effects resulting from the treatment of cancer for teenage children. For example, in a recent study of 121 elderly people, computer puzzle games such as *Tetris* were used as a trial against a computerised cognitive training program called *"Mindfit"* (Korczyn, Peretz, Aharonson & Giladi, 2007). The results showed that both the games and the program improved short-term memory, spatial learning, and attention skills. The researchers stated that although the *Mindfit* program improved skills to a greater percentage, the games also significantly improved skills after relatively short periods of play. The participants were required to play 3 times per week for half an hour each session over a period of 3 months, and it is suggested that this may assist with the treatment of the early onset of Alzheimer's disease.

In an earlier study by Gottfried (2004), 14 children suffering from Attention Deficit or ADHD, were requested to play a game-like cognitive training program, three times per week for duration of 20 minutes. After a period of between 12 and 22 weeks, all participants reportedly showed significant improvements in attention span, behavior, and academic achievement.

Pearson and Bailey (2008) approached the task from the hardware viewpoint, using Commercial-off-the-shelf (COTS) games with the Nintendo Wii. Their work with disabled students showed that not only could the Wii promote improvement in physical movement, but also assisted with the social and self-esteem issues of their participants. They conclude with the call for teachers to work together and develop lesson plans to incorporate such devices.

"The Wii promotes improvement in physical movement, but also assisted with the social and self-esteem issues."

In summary, Griffiths (2005) states that video games have positive potential for therapeutic and rehabilitation applications. He suggests that applications developed in the education and health sections using video games have been successful but calls for further research to be done in these areas.

Frameworks for Game-Based Learning

Brown (2002) states that learning comes as the result of a framework or environment that fosters learning rather than as a result of teaching. He maintains that today's students look upon technology as an integral part of life and a tool that they take for granted; for many of them computing has been part of their learning since early childhood. Brown suggests that there is a shift in the way that students learn. At tertiary level, this has only been embraced by a handful of institutions, creating a problem in student retention. The shifts include the literacy's used, from text to multimedia; classroom practice, from teacher-centered to student-centered; and reading, from solitary to social exploration. It has been claimed that video games are ideally situated to cater for these students. Oblinger (2004) suggests that educational environments involving video games lead to deeper learning, and Buchanan (2000) states that the cognitive conflict from video games enhances learning.

Human behavior is learnt and decisions are made by evaluating the situation and considering all the options. Buchanan (2004) notes that game designers challenge players by using "bots" or non-player characters (NPCs) in their games that mimic human behavior. Bots do this by using what programmers call a decision tree. Human players do it intrinsically by monitoring the situation and manipulating it based on their own thoughts and perceived skill set. This is meta-cognition. Buchanan claims that experienced players consciously increase their mental space for visualization and manipulation of problems. He suggests that game players possess an increased ability to multitask and mentally sort information. Buchanan concludes that video games include all the underpinning characteristics for quality learning. Garris et al., (2002) list these characteristics as being:

- Fantasy – Imaginary or fantasy context, themes, or characters.
- Rules/Goals – Clear rules, goals, and feedback on progress towards the goals.
- Sensory Stimuli – Dramatic or novel visual and auditory stimuli.
- Challenge – Optimal level of activity and uncertain goal attainment.
- Mystery – Optimal level of informational complexity.
- Control – Active learner control.
-

Garris et al. (2002) also agree that substantial part of the learning is achieved outside of the game cycle during reflection and debriefing (refer figure 1).

"Human players do it intrinsically by monitoring the situation and manipulating it based on their own thoughts and perceived skill set".

Player Immersion for Enhanced Learning

Beazzant (1999) states that the characteristics of commercial video games create an environment where players are compelled to play to the extent of forming addictions. Garris et al., (2002) maintain that this addiction, or persistent re-engagement by the player, is what instructional designers strive to create when designing tutorials and educational software. with the player or learner continually repeating the game cycle, video games foster behaviourism and the learning is achieved from drill and practice. Yet de Castell and Jensen (2003) argue that many educational games are not successful because they fail to immerse the play the way commercial video games do, and it is this immersion that fosters a deep learning, not the low level of learning from drill and practice.

"Video games are practice opportunities for cognitive skills" (Quinn, 1997, p.1).

In the study by Kearney (2005), the game *Counter-Strike* was observed to immerse the player in the game. Two teams of eight players sat quietly and focused for over two hours in what appeared to be very serious game play. Yet other teams in the same study played a similar game called *Quake III* and no player immersion was observed. The difference between the two games was that *Quake III* did not create same level of challenge nor difficulty that *Counter-Strike* did. *Counter-Strike* also had more rules, consequences of failure were increased, and the goal of the game was detailed enough to inform the player of the relevance of the game play, as suggested earlier in the list of characteristics by Garris et al., (2002).

Quinn (1997) claims that video games can be highly effective when used in an educational environment. He also cites the concept of *flow* from Czikszentmihalyi (1990), in conjunction with Malone's (1981) critical elements of fantasy, challenge, and curiosity; both concepts are used and extended by Garris et al., (2002) for their model of GBL. Quinn goes further to suggest that Malone's challenge element is what maintains player engagement and creates a "zone of difficulty where learning occurs". This could also be compared to Vygotsky's (1978) Zone of Proximal Development (ZPD), where the scaffolding or level of cognitive challenge must be appropriate for the learner's current abilities or learning will not occur. Quinn argues that cognitive challenges within the game lead to the practice of skills for problem solving. This may be perceived as drill and practice, however it can be called "recursive learning".

The success of any computer game, be it recreational or educational, is dependant on the engagement of the player during the first and subsequent interactions. A literature search of desired game characteristics results in varied opinions, however they all suggest that the success of a game is increased when the immersive characteristics of that game focus the attention of the player. They state that when immersion occurs, meaning the loss of time through the complete focus on the task at hand, the game motivates the player to repeatedly engage in play. This type of motivation has been described as flow. The concept of flow can be used to identify which video games foster the persistent re-engagement of the player and eye-tracking technology can be utilized to verify player immersion. However, unless the game scaffolds the player's abilities, this immersion will be lost and the game will fail. The player's abilities are incremented in a recursive loop and this is shown in the described model. The scaffolded level of skill requirement is what creates the immersion and the player's desire to engage.

"The game motivates the player to repeatedly engage in play."

A Constructivist GBL Platform

There are specific educational domains where game-based learning concepts and approaches have a high learning value. These domains are interdisciplinary topics where skills such as critical thinking, group communication, debate and decision-making are of high importance. Such subjects, if learned in isolation, often cannot be applied in real world contexts. To create a successful game-based learning opportunity, defined steps of game design with elements of learning and engagement should be taken into consideration (Pivec & Pivec, 2008). The main areas to be considered are as follows.

- Determine a pedagogical approach for the lesson plan (how you believe learning takes place)
- Situate the task to achieve the learning outcome in a model world
- Elaborate on the details needed to complete the task
- Incorporate the underlying pedagogical support
- Map the learning activities to interface actions of the game
- Map the learning concepts to interface objects on the game

When designing an example of an educational game we have to reflect upon didactical approach and related topics. We have to create the situation asking, “What do we want that learners learn?” Before defining the activities we should reconsider the saying *failure opens the gate to learning* and we should try to provide an answer to the question “Why?” There are many interactive learning techniques that have already been used in game-based learning. One of those techniques is learning from mistakes, where failure is considered a point where user gets some feedback. In game-based learning making a mistake - or trial and error - is a primary way to learn and is considered the motivation for players to keep on trying. In games, we learn through failure and consequence and feedback is provided in the form of action (as opposed to feedback in the form of the text explanation that is provided in instructional material).

“Students designing and creating their own educational games encourages meta-level reflection and fosters creativity.”

Salen (2007) and Buckingham, Burn, and Pelletier (2005) advocate that allowing students to design and create their own educational games encourages meta-level reflection and fosters creativity. Yatim (2008) from the University of Magdeburg, tested this with students between the ages of 9 to 12, and found through designing their own educational games, students appeared to be enthusiastic and showed a high level of interest. Prensky (2006) also suggests that games design by students for students would have a higher level of engagement, although no supporting research was offered. However, this would possibly overcome some of the barriers to acceptance (Rice, 2007) by allowing teachers to work with students aligning the game content to the curriculum.

However, there are various platforms available that offer an environment where teachers and trainers can define there own on-line role playing scenarios or simulation, and provide the opportunity for learners to apply factual knowledge and to gain experience through the digital world. Teachers can define new games or adopt and modify sample games without any programming skills. Products such as *“Unigame”*, *“Fablusi”*, and *“The Training Room”* provide a variety of communication means within the scenarios; players can communicate with the use of discussion forums, text and voice chat modules as well as through multi-user video conferencing. An important feature of these products is the collaborative learning design, which allows participants to exchange information as well as to produce ideas, simplify problems, and resolve the tasks. When using these platforms, the teacher is the active partner, moderator and advisor of the educational process (Pivec & Pivec, 2008).

Simulations versus Role Play Games

Salen and Zimmerman (2003) define games as systems where a player engages in conflict defined by a defined set of rules and the result is a defined outcome. They argue that while games and role-plays share the key features that define them both as games, they are different in one critical respect; role-plays do not always have a defined outcome. However, Salen and Zimmerman concede that this depends on the framework or platform that provides the role-play. They suggest that where a game and a role-play overlap is that they are systems requiring players to interact according to a set of rules in a contest or in conflict (Salen & Zimmerman 2003).

Linser (2008) suggests that for pedagogical purposes, a role-play is closer to a simulation than a game. Linser argues that with the acquisition of real world knowledge, and the understanding and skills acquired by the player, a role-play is designed as an attempt to simulate processes, issues and conditions that exist in the real world.

"A role-play simulation game is thus a dynamic artificial environment in which human 'agents' interact by playing roles with semi-defined characteristics, objectives and relations to one another and within a specified scenario" (Linser, 2008, p.5291).

Kelly (2005) argues that simulations have an enormous impact on education and many products such as Microsoft's "*Flight Simulator*" are in fact simulations and neither games nor role-plays.

In the model of game-based learning shown in *figure 3*, the inclusion of instructional design is a critical element of the game to enable the achievement of the learning outcomes. Akilli (2007) argues that while game designers need to improve their instructional design and equally, instructional designers need to give more attention to game design principles, there is a lack of guideline documentation supporting this area of pedagogy.

Linser (2008) concludes by stating that while he considers role-play as a simulation, given the right environment and delivery platform, a role-play can include all the engagement, immersion, and motivation that is inherent in the game environment. Fortugno and Zimmerman (2005) agree and suggest that teachers and trainers do not yet understand the use and potential of games and most games to not include sound pedagogical principles in their design.

"A role-play can include all the engagement, immersion, and motivation that is inherent in the game environment."

A Level-up for the Teachers

Although when surveyed, the majority of teachers are willing to incorporate video games into their lesson plans, most of the research, techniques, and the appropriate games are rarely promoted to them and they seldom read the journals where this is published (Sprague, 2004).

Video games and their appropriate use for education vary considerably. Taxonomies of game types and lists of recommended games are available (Pivec, Koubek, & Dondi, 2004; Pivec, 2008) but teachers cannot be expected to know how to integrate the games into their lessons to achieve the desired learning outcomes. Also the games themselves can take a considerable amount of time to learn, often with the students knowing more about the game than the teacher.

Becker (2007) addressed this problem with a course to teach the teachers about commercial video games and the use of them within a classroom environment. The course ran for six weeks, with the participants meetings for three hours, twice per week. The participants were given a choice of two projects; (1) to design an educational game and complete a professional design concept similar to the course by Pivec and Kearney (2007), [see section 4.2] or (2) to design a lesson plan to use an existing commercial computer game. Throughout the duration of the course, topics discussed included the appropriateness of violent games, instructional design of commercial games, varying platforms fro gamers, and how to assess the games themselves. Specific games were also analysed and these included commercial recreational games such as *"Black and White",* and free to use online games such as *"Food Force"*. The playing of the games was a key feature of the course.

Becker (2007) rated the course as a major success but stated that with only 18 participants out of a local teacher population of over 10,000, she had not solved the problem. Becker concludes by stating that her objective was not to turn the teachers into computer game players, but to encourage them to play games and critique them for use within their lessons.

"Teachers cannot be expected to know how to integrate the games into their lessons to achieve the desired learning outcomes."

Conclusions

Video games have been around for many years and game-based learning has been the topic of many publications. Research results suggest that either the game itself or the environment in which it creates, can enhance the learning process. However, the uptake of this technology in the classroom has been slow with the major barriers being a lack of knowledge by the teacher in how to use the resource, a lack of time to prepare in adapting the game for the curriculum, and a lack of adequate technology. Teachers are trained in traditional methods that do not include the use of games in the curriculum. Only researchers and a few innovative teachers have successfully embraced video games for learning, although many others are willing to do so given the correct resource and assistance to do so.

Surveys in both the UK and the US show that students are critical of educational games as the expected quality of a commercial recreational game is often missing. Modifying commercial games has become popular to avoid this, as has allowing the student to design their own game – either to concept level or a prototype if resources allow. Where a game is utilized as part of a lesson, a commercial-off-the-shelf (COTS), and often a recreational game, or a commercial game that has been modified or adapted for the desired learning outcome can be used. This has been done successfully as highlighted in the above literature, but care must be taken to adhere to the comprehensive licensing agreements of the publisher. As games can extend outside the classroom, they also provide an ideal platform for study aids and to assist with learning impairments and the medical profession has been quick to appreciate the benefits of this technology.

Games for learning vary from single player to multiplayer games. Different types of games have different sets of features that have to be considered in respect to their application for education. For declarative knowledge, features such as content, assessment ability, and the scaffolding of levels along with time constraints, are all very important. To acquire skills, games must be session based, where attention is paid to the graphical details, this enabling an immersive situation. In the area of decision-making and problem solving, games should be narrative based where chance is a factor, accurate in the problem descriptions, with background knowledge of the content being vital to successful completion. Role-play games and simulations provide ideal and safe environments for learning. If learning is defined as the acquisition of knowledge or skills through experience, practice, or study, and learning outcomes are the knowledge, skills and abilities that the student will possess following the learning experience, then video games can be used as supplement to traditional teaching.

“Role-play games and simulations provide ideal and safe environments for learning.”

However, part of the process of choosing and utilizing video games for learning includes the identification of and consideration for constraints in the learning setting, computer skills of both students and teachers, and the knowledge of how the desired learning outcomes will be realized. Other issues include technical requirements, licensing policies, sustainability, and more. Video games are an untapped resource in the field of education and will remain so until adequate teacher resource is provided.

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Appendices:

Glossary of Game Terminology

Action Game:	This genre focuses on speed, physical drama with high demands on the player's reflexes and coordination skills.
Active Learning:	Instructional activity involving students in educational process by design group discussions, debating, brainstorming, problem solving, case studies, role plays, journal writing, answer questions, etc. The method benefits include increased motivation and transfer of new information, improved critical thinking skills and sophisticated interpersonal skills.
Adventure Game:	This genre focuses on puzzle solving within a narrative framework relying on the player's ability to think logical.
Avatar:	An avatar is an interactive representation of a human figure in a games-based or three-dimensional interactive graphical environment.
Commercial game:	An overall term for video games that are sold through traditional distribution channels.
Computer game:	Often used as a generic term for electronic games, but for the purpose of this report, a computer game is played on a PC or Mac Computer. Whereas a video game also refers to console games; xbox, playstation, Wii, etc.
COTS:	An abbreviation used for "Commercial Off The Shelf" video games, typically recreational games bought in a retail store.
Drill-and-practice software:	Software that primarily relies on training a number of very specific skills by letting the user repeats the activity endlessly.
Educational games:	Games for learning are often imaginary (e.g. fantasy) interactive and immersive environments in which role play, skills rehearsal and other learning (e.g. collaborative or problem-based) may take place individually or in teams.
Game-Based Learning:	Instructional activity using video games in blended education for improving, accelerating and high- motivating of learning process.
Game console:	A game console is an electronic machine for playing dedicated video games. Game consoles may need a separate output device e.g. television or a PC monitor. The main input device is a games controller, e.g. hand controller, joystick.
Game design:	The visualization of the game concept, how game will look, work, etc. All that exists in game must be appear and described in Design Document.
Game engine:	Each computer, video game or interactive application with synchronous graphics has a game engine. The game engine is the central software component, providing the underlying technologies. The engine greatly simplifies the task of games development, and often allows the game to be used on different platforms, e.g. different game consoles and PC operating systems.
Immersive world:	Immersive world is a term used in this report to mean simulations, games and other interactive, often 3D virtual spaces, or crossover spaces (e.g. between virtual and real).

Level-up:	The term used when a player achieves the requires knowledge and skills to progress to the next level of the game. In Multiplayer games, the higher levels are more difficult and the players also enjoy a higher social ranking with the player community.
MMO or MMORPG:	An abbreviation for massive multiplayer online game in which a large number of players interact with one another in a virtual world.
Platform Games:	Typically 2D games involve climbing ladders, jumping between platforms or jumping over objects in order to achieve a specific goal.
Role Play:	Learning activity in which the student behaves in the way somebody else would behave in particular situation. Role-play allows student to practise in a safe situation.
RPG:	An abbreviation for role-playing games in which the participants assume the roles of fictional characters and collaboratively create or follow stories. Participants determine the actions of their characters based on their characterization, and the actions succeed or fail according to a formal system of rules and guidelines
RTS:	An abbreviation for real-time strategy games that refer to a combination of action a strategy typically involving resource management and the waging of war.
Simulation:	Games where realism is first priority. The player's ability to understand and remember complex principles and relations is paramount. Simulations represent real-world systems; they contain rules and strategies that allow flexible and variable simulation activity to evolve.
Strategy Game:	Genre where the ability to make deal with dynamic priorities is key.
Video game:	A generic term for electronic games that are designed for and played on a PC or Mac Computer as well as a console (xbox, playstation, Wii) or handheld device (PSP, Nintendo DS, Gameboy).
Web-based Game:	Games that are played through web browser and written in an Internet language such as HTML, Java, Perl, PHP, and Flash.

Useful Internet links of Educational Game Resources

http://www.socialimpactgames.com/

The goal of this site is to catalog the growing number of video and video games whose primary purpose is something other than to entertain.

http://www.virtualworldsreview.com/info/categories.shtml

This site contains a comprehensive list of Virtual Worlds, both free and subscriber, social and educational use.

http://www.supersmartgames.com/

Reviews, blogs, video, and links to train your brain type games.

http://www.e-learningcentre.co.uk/eclipse/Resources/games.htm

A collection of selected and reviewed links to e-Learning and GBL resources.

http://www.shambles.net/pages/learning/games/research/

This website is designed to support the international school communities *(teachers, support staff, administrators, students and families)* in 17 countries in South East Asia. The links points to their Games research page.

http://www.swingame.com

SwinGame is a game development API, and set of software development kits, for students who are learning to program.

http://www.thinkingworlds.com

Thinking Worlds is a learning educational 3d game authoring engine, free for education use.

http://www.seriousgames.org/index2.html

The Serious Games Initiative is focused on uses for games in exploring management and leadership challenges facing the public sector in the United Sates.
http://www.sig-glue.net

SIG-GLUE - Special Interest Group for Game Based Learning in Universities, EU E-Learning Initiative.

http://simge.metu.edu.tr/fen/index.htm

Modification of popular commercial game Tomb Raider from, METU, School for Educational TechnologyGame. Subjects cover Level-1: Photosynthesis, Level-2: Vitamin, Level-3: Fat, Protein, Carbohydrates. Free to download.

http://www.unigame.net/

An EU funded project for online role-play scenarios in Universities.

http://www.gamedesigncampus.com/

Multi-user learning platform, *"The Training Room"*. Based on multi-user Flash technology and Video Conferencing. Scenarios available for Schools, Universities, and Industry.

Bibliography of Authors

Maja Pivec

Maja Pivec, Ph.D, is Professor of Game Based Learning and e-Learning at the University of Applied Sciences FH JOANNEUM in Graz, Austria. During the years of 1993 to 2004 she received numerous international grants and awards for her research in the field of innovative computer-based learning approaches and knowledge based systems. For her research achievements Maja received in the year 2001 Herta Firnberg Award (Austria) in the field of computer science. In 2003 she was awarded by European Science Foundation in form of a grant for an interdisciplinary workshop organisation in the field of affective and emotional aspects of human-computer interaction, with emphasis on game-based learning and innovative learning approaches.

Maja is co-ordinator, scientific leader or partner in several EU or national funded projects and the editor and co-editor of several book publications in the area of innovative learning approaches. She was guest editor of British Journal of Educational Technology, Special issue on learning from games, May 2007. Her research work is published and presented at more than 90 international conferences and publications, including many keynote and invited talks.

Maja is member of Laboratory For Decision Processes And Knowledge-Based Systems, University of Maribor, Faculty of Organizational Sciences, Slovenia, and is an international advisory board member of MJET – Malaysian Journal of Educational Technology. She is a Program Committee member of GAMEON and F.R.O.G. (Future and Reality of Gaming) conferences. Maja also reviews for the European Science Foundation and the British Journal of Educational Technology (BJET).

Maja continues to publish on a regular basis and actively teaches game-based learning through the successful course “Role-Playing the Computer Game Industry” – a tertiary level curriculum developed by the authors.

Maja’s full academic resume can be viewed on http://www.majapivec.com.

Paul Pivec

Paul Pivec has over 30 years in the computing industry and 7 in academia. Originally a systems programmer, but with many years in networking and multimedia, Paul has owned and managed two multi-million dollar development companies with a customer base that included the New Zealand and Australian Governments, and multinational companies NCR and Hitachi. In the decade prior to the World Wide Web, Paul's company *Trinet*, was the first to bring multi-protocol compatibility to networks across Australia. As managing director and lead designer, Paul's development team pioneered graphical interfaces for text based management systems and subsequently sold the technology to AT&T.

With his experience in development and management, coupled with his entrepreneurial skills, Paul has successfully mentored start-up ventures such as the Video game development company, Metia Interactive. From their initial conception of a commercial game idea, Paul coached them to the achievement of a national innovation award, and finally to bring their product to the world market through the Sony Interactive distribution channel. In recognition of his work, Paul has been an invited judge for the Australasian media and technology awards on successive occasions.

Having completed a Masters Degree in Game-Based Learning, and a Graduate Diploma in Higher Education, Paul is now completing a PhD to show the cognitive abilities gained from playing computer games. Now based in Europe, he is also combining his knowledge in pedagogy with his development skills to complete his latest project in multi-user game-based learning via the Internet. Paul still consults to game development companies both in Europe and down-under, and is actively publishing and presenting at conferences, as well as being guest lecturer on an ad-hoc basis.

Paul's academic history and publication list can be seen at http://paulpivec.gdcradical.com.

Game Over.