Literature Review in Games and Learning

John Kirriemuir, Angela Mcfarlane

FUTURELAB SERIES

REPORT 8:

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CONTENTS:

EXECUTIVE SUMMARY 2
SECTION 1 INTRODUCTION 5
SECTION 2 GAMES CULTURES AND PLAY 7
SECTION 3 GAMES AND LEARNING 13
SECTION 4 KEY ISSUES IN DEVELOPING GAMES FOR LEARNING 19
SECTION 5 FUTURE DIRECTIONS IN GAMES AND LEARNING 24
BIBLIOGRAPHY 29
END NOTES 34

FOREWORD

Computer games are today an important part of most children's leisure lives and increasingly an important part of our culture as a whole. We often, as adults, watch in amazement as children dedicate hours to acting as football coaches, designers of empires, controllers of robots, wizards and emperors. In the past, computer games have been dismissed as a distraction from more 'worthy' activities, such as homework or playing outside. Today, however, researchers, teachers and designers of learning resources are beginning to ask how this powerful new medium might be used to support children's learning. Rather than shutting the door of the school against the computer game, there is now increasing interest in asking whether computer games might be offering a powerful new resource to support learning in the information age.

This review is intended as a timely introduction to current thinking about the role of computer games in supporting children's learning inside and out of school. It highlights the key areas of research in the field, in particular the increasing interest in pleasurable learning, learning through doing and learning through collaboration, that games seem to offer. At the same time, the review takes a measured tone in acknowledging some of the obstacles and challenges to using games within our current education system and within our current models of learning. It goes on to propose some ways in which designers, researchers and educational policy makers might draw on the growing body of research in the field to create learning resources and environments that go beyond a sugar-coating of 'fun' to the full engagement that computer games seem to offer so many children today.

We are keen to receive feedback on the Futurelab reports and welcome comments at research@futurelab.org.uk

Keri Facer
Director of Learning Research
Futurelab

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

AIMS

This review provides:

- a summary of the contemporary state of the computer and video gaming industry, market and culture
- an overview of the main developments in research into gaming and the educational relevance of video games, and a summary of the literature resulting from this research
- a basis for communication between the educational research community and the commercial sector on the subject of the use of games technologies in the design of learning resources
- a basis for discussion within educational communities on the use of digital games within educational settings.

attempts to generalise the effect of games or gaming may be unhelpful

CONTEXT

Computer games are a growing part of our culture; the global market is worth billions of dollars, related activities range from published magazines to spontaneous internet communities, and the impact of games play on young people has attracted significant interest from the popular media. Three quarters of children play regularly – is this harmful or beneficial, are they learning as they play, and if so what? This review considers the findings of research into the relationship between games and players, and the theoretical and actual implications for learning.

The research evidence is complex, and thinly spread. The study of computer games, or game players, cannot be mapped onto one research discipline. Relevant areas of study include, but are not limited to computer science, education, psychology, youth and media and cultural studies. As a result, aspects of investigation into games and game players can 'straddle' several different academic disciplines.

As games have become more complex in terms of graphics, complexity, interaction and narrative, so a variety of genres have come to dominate the market. There is, however, no standard categorisation of such games; different stakeholders in the games industry eg game outlets, developers, academics, web review sites, use a taxonomy appropriate to their own audience. Nonetheless the differences between genres, and even between games within one genre, differentiate the way they are played, and their potential to support learning. Thus attempts to generalise the effect of games or gaming may be unhelpful.

Perhaps as a result of the diversity and complexity of games themselves, and the range of perspectives taken by researchers, there are few hard and fast findings in the literature. In order to better understand games and game play, and how they contribute to learning, it may be necessary to distinguish more clearly the nature of gaming and the nature of learning and the learner.

GAMES AND GAMERS

Researchers and commentators have attempted to understand the lure of computer games. This has been characterised as a combination of fantasy,

challenge and curiosity, and a level of engagement described as 'flow' where players become oblivious to distractions. Concern has been expressed that this leads to a neglect of other activities, often assumed to be automatically more worthy. Other authors see games play as inherently valuable, leading to a development of a range of skills and competences that may transfer to other social and work-related uses of digital technologies.

The debate around violence and gaming is as yet unresolved. There are two perspectives; that games increase aggression or that games provide a release for pent-up aggression. In all likelihood both are legitimate conclusions, and the outcomes varies with game and player.

Gender is a common subject of games related research, focusing mainly on the image of females within games, or the role of gender in influencing games play. There are few clear outcomes, but the proportion of gamers who are female seems to be growing and this may be related to the increase in social gaming through on and offline multiplayer options.

GAMES AND EDUCATION

Research into the use of mainstream games in education is relatively novel, but growing rapidly. Research is mainly concerned with the development of related competences and literacies during game play, or the role of games in the formation of learning communities either while gaming or related to game play.

Use of mainstream games in schools remains rare, and is unlikely to be integrated into the curriculum. Reasons for this include:

- it is difficult for teachers to identify quickly how a particular game is relevant to some component of the statutory curriculum, as well as the accuracy and appropriateness of the content within the game
- the difficulty in persuading other school stakeholders as to the potential/actual educational benefits of computer games
- the lack of time available to teachers to familiarise themselves with the game, and methods of producing the best results from its use
- the amount of irrelevant content or functionality in a game which could not be removed or ignored, thus wasting valuable lesson time.

Nonetheless, teachers and parents recognised that games play can support valuable skill development, such as:

- strategic thinking
- planning
- communication
- application of numbers
- negotiating skills
- group decision-making
- data-handling.

Significantly the experience of game play seems to be affecting learners' expectations of learning activities. Preferred tasks are fast, active and exploratory, with information supplied in multiple forms in parallel. Traditional school-based learning may not meet these demands.

the experience of game play seems to be affecting learners' expectations of learning activities

EXECUTIVE SUMMARY

concealing the learning within educational games may be a red herring

DEVELOPING GAMES FOR EDUCATION

There are two key themes common to the development of games for education, namely:

1 The desire to harness the motivational power of games in order to 'making learning fun'.
2 A belief that 'learning through doing' in games such as simulations offers a powerful learning tool.

Software designed to support young people's learning often borrows from game design in an attempt to replicate the levels of engagement and harness this to facilitate more traditional learning. These attempts are not always successful and the results do not always convince a discerning gamer.

Most edutainment has failed to realise expectations, either because:

- the games have been too simplistic in comparison to competing video games
- the tasks are repetitive ie continually doing sums, and thus quickly become boring and 'work'
- the tasks are poorly designed and do not support progressive understanding
- related to this last point, the range of activities is severely limited within the game, usually concentrating on one skill, or accumulation of homogenous content
- the target audience becomes aware that it is being coerced into 'learning', in possibly a patronising manner.

The debate on 'making learning fun' often assumes that children do not enjoy learning. Yet much research evidence contradicts this, arguing that children do enjoy learning when they have a sense of their own progression and where the learning is relevant and appropriate. This focus on 'fun' and on 'concealing the learning' within educational games may, in fact, be a red herring. Instead, it might be worth returning to some early analyses that describes the pleasures of games play as a 'flow'.

The conditions likely to induce the flow state are characterised by Malone (1980) as:

- the activity should be structured so that the player can increase or decrease the level of challenges faced, in order to match exactly personal skills with the requirements for action
- it should be easy to isolate the activity, at least at the perceptual level, from other stimuli, external or internal, which might interfere with involvement in it
- there should be clear criteria for performance; a player should be able to evaluate how well or how poorly (s)he is doing at any time
- the activity should provide concrete feedback to the player, so that (s)he can tell how well (s)he is meeting the criteria of performance
- the activity ought to have a broad range of challenges, and possibly several qualitatively different ranges of challenge, so that the player may obtain increasingly complex information about different aspects of her/himself.

Another commentator, reflecting on how to design engaging learning experiences, draws on these definitions to propose eight characteristics as essential:

INTRODUCTION

- task that we can complete
- ability to concentrate on task
- task has clear goals
- task provides immediate feedback
- deep but effortless involvement (losing awareness of worry and frustration of everyday activity)
- exercising a sense of control over our actions
- concern for self disappears during flow, but sense of self is stronger after flow activity
- sense of duration of time is altered.

Rather than aiming for an experience that superficially resembles leisure-based 'fun' activities, or one which attempts to conceal the educational purpose, it might be argued that we should understand the deep structures of the games play experience that contribute to 'flow' and build these into environments designed to support learning.

1 INTRODUCTION

As is widely reported across many media, computer and video games are increasingly popular. In 2002, the world market for 'games and edutainment/ reference software' realised 16.9 billion US dollars, with 3.3 million games consoles being sold in the UK alone (ELSPA 2003). People of all ages, but most visibly children, play these games, often dedicating long periods of time in total concentration to the amazement and sometimes concern of watching adults.

Games were still a relatively new phenomenon when a wide range of people, including parents, teachers, educational specialists and media commentators began to ask one of two related questions:

1 Games take up large periods of time, which could be spent on more worthy activities, such as education and learning. Therefore, how do we 'wean' children off games and into these activities?

2 Games promote levels of attention and concentration that teachers, parents and policy makers wished children applied to learning. Therefore, what can the education sector learn and use from these games in order to 'enhance' the learning process?

This report examines the research associated with these two stances on games and learning. Particularly, it examines three research questions:

1 What is happening during the game-playing process, and what can the educational sector learn or use from this?

in 2002, the world market for 'games and edutainment/ reference software' realised 16.9 billion dollars

INTRODUCTION

2 Can conventional computer games be used as a vehicle for formal learning, eg classroom-based curriculum related content delivery?

3 What components or features of conventional computer games can be taken and used in learning software or practice?

The key focus of this report is primarily on school age children, and the design of games (both for learning and for leisure) for children of these ages.

1.1 DEFINITIONS AND RESEARCH BASE FOR THE REPORT

There is a wide variety of definitions of digital games across the range of academic, internet and media writing. The terminology also varies between authors and over time, and is often interchangable. For example, the terms 'computer game' and 'video game' used to refer to PC-based games and console-based games respectively but are now used interchangeably.

For the purposes of this report, we will define a digital game as one that:

- provides some visual digital information or substance to one or more players
- takes some input from the players
- processes the input according to a set of programmed game rules
- alters the digital information provided to the players.

We will also define games as programmes that operate on the following platforms:

- hardware, known as video game consoles (examples being the Sony Playstation series, Microsoft Xbox and Nintendo GameCube), which are operated through a television
- personal computers
- mobile devices, eg phones and dedicated gaming machines such as the Nintendo GameBoy Advance.

Digital games will include those that are mass-market products developed for the leisure or education market, including those with cross-over potential.

Niche digital gaming media, such as watch or LCD panel-based games, are outwith the scope of this report since at present they are somewhat ephemeral and simplistic.

1.2 RESEARCH ISSUES AND CREDIBILITY

There are three key issues surrounding research into games and learning that require acknowledgement.

- **Games and publication cycles**

  The time taken for peer reviewed articles to reach publication often means that games described as 'current' may be somewhat out of date compared with current market practices. This is not to say that this research has no lessons to offer developers and teachers, simply that it is important to supplement conventional academic research with research from other sources, while at the same time recognising that these alternative sources are not subject to the same degree of peer-reviewed scrutiny as academic publications .

GAMES CULTURES AND PLAY

- **Games as an interdisciplinary subject**

  Games have been a subject for research in a wide range of different fields, including computer science, media and cultural studies, psychology, education, physics and youth studies. For anyone interested in games and learning, then, there are two challenges: first, to locate all the research across all these areas and second, to overcome the sometimes confusing overlap and difference in terminology used in respect of games across these different research fields.

- **Games researchers as 'defenders' of games**

  Given the many social concerns around computer games, many researchers in this field find it necessary to defend computer games against attacks. Those reading the research need to adopt a balanced perspective towards accounts that can sometimes be read as a 'celebration' of games in the face of sustained social criticism. Additionally, readers need to beware of a tendency for some researchers to generalise from personal experience and to be cautious of accounts that attempt to describe 'typical games players'.

2 GAMES CULTURES AND PLAY

2.1 CATEGORISING GAMES

As games have become more complex in terms of graphics, complexity, interaction and narrative, so a variety of genres have increasingly come to dominate the market. There is, however, no standard categorisation of such games; different stakeholders in the games industry, eg game outlets, developers, academics, web review sites, use a taxonomy appropriate to their own audience. Such categorisations are discussed in Orwant (2000), who also illustrates the system employed by Herz (1997) which closely resembles that used by many in the contemporary games industry.

The Herz system presents these major categories:

- **action games** - these can be subcategorised into shooting games, 'platform' games (so called because the players' characters move between on-screen platforms) and other types of games that are reaction-based
- **adventure games** - in most adventure games, the player solves a number of logic puzzles (with no time constraints) in order to progress through some described virtual world
- **fighting games** - these involve fighting computer-controlled characters, or those controlled by other players
- **puzzle games** - such as Tetris
- **role-playing games** - where the human players assume the characteristics of some person or creature type, eg elf or wizard
- **simulations** - where the player has to succeed within some simplified

GAMES CULTURES AND PLAY

recreation of a place or situation eg mayor of a city, controlling financial outlay and building works

- **sports games**
- **strategy games** - such as commanding armies within recreations of historical battles and wars.

Even with this taxonomy, there are exclusions; a small number of games will be released every year that defy categorisation. In addition, some games fall into more than one category; for example, football manager games (where you buy, sell, select and position players) arguably fall into the categories of simulation, strategy and sports games. This classification also leaves out the individual or multiplayer contrast, which is making a real difference to how games can be played.

2.2 THE PREVALENCE OF GAMES PLAY

Statistics for game hardware and software revenue and the volume of players indicate a major social and entertainment culture (though the actual 'size' of the mainstream video game industry at present is open to interpretation). Industry commentators and digital game researchers often quote game statistics in relation to other media. For example, Sony's Playstation2 console launched in Japan in February 2000, selling 980,000 units in its first weekend and thus becoming the biggest launch of any electronic consumer device in history (Poole 2000). There is also the oft-quoted observation that over the Christmas 1998 period in the US, one videogame (Zelda: Ocarina of Time) grossed $160 million, far exceeding the most popular cinema film (A Bug's Life). However, such simplistic comparisons are increasingly questioned; for example, the aforementioned comparison does not take into account the cost of the game ($50) against that of the cinema ticket ($6), the demographics, release dates, or the life of the product, since it is common for up to 90% of film revenue to be generated from DVD and video rather than cinema release.

The recent transfer of characters between computer game and cinema screen is evidence that computer games, once seen as a minority interest, are increasingly an established and powerful aspect of our cultural landscape. Such transfer does not always work; many of the game 'brands' that have been turned into movies, such as Resident Evil, Mario Brothers and Tomb Raider, have been poorly received by both critics and audiences. Similarly, most attempts to produce 'spin-off' video games based typically on summer blockbuster movies have been poorly received by critics and have failed ultimately to sell in the volume that successful games titles now do.

That said, digital games are clearly an important part of most young people's lives today. Recent figures suggest that nearly 70% of children play computer games every week, and mobile games play is increasingly common, with 68% of children playing games on their phone every week (Facer 2001). A growing body of research points to games currently being the most frequently used 'interactive media' amongst children. Beentjes (2001) and Feierabend & Klingler (2001) showed that playing games was the most prominent PC-related activity of children between 6 and 13.

2.3 WHY DO PEOPLE PLAY GAMES?

Research on the motivations for games playing have been carried out by researchers across a number of disciplines. One of the earliest, and most cited, research works is by Thomas Malone (Malone 1981) who identified three main ways in which games were able to motivate players: fantasy, challenge and curiosity. Other research confirms these findings; for example, in research using educational software, Amory et al (1988) identified curiosity ("what happens if I do this") as a common motive in playing a game. Presumably the fact that something does happen encourages players to proceed, and the quality of what happens in terms of user engagement is the factor that keeps them playing. The TEEM data suggests that degree of difficulty is important here; for children to enjoy playing, the game must be neither too difficult nor too hard (McFarlane et al 2002).

A key concept that frequently emerges in the literature is that of 'flow', first discussed by Csikszentmihalyi (1990). This is summarised by several researchers as "the state in which we are so involved in something that nothing else matters", which has clear relevance to research into games and play. Debate on the issue of 'flow' centres around how the 'state' can be created in an individual, and measuring how it might make a person more receptive to receiving, comprehending and using educational-based content and skills (we will go on to discuss in more detail how 'flow' might apply to the design of learning games in Section 4).

A 2001 survey (ESA) produced four main reasons for gameplay, namely:

- 87% of most frequent computer and video game players said the number one reason they play games is because it's fun
- games are challenging (72%)
- games are an interactive social experience that can be shared with friends and family (42%)
- games provide a lot of entertainment value for the money (36%).

Therefore, no clear consensus emerges on the reasons why people play digital games. This is unsurprising since the games themselves vary enormously and, as some researchers point out, the individuality of the player provides a sometimes complex set of reasons for game play. Poole (2000) notes that:

"Videogames are powerful, but they are nothing without humans to play them. So the inner life of videogames - how they work - is bound up with the inner life of the player."

2.4 CONCERNS AROUND COMPUTER GAMES PLAY

2.4.1 Games displacing other activities

The impression of much of the mass-media, and some research, is often of a population of children playing video games to the exclusion of all other activities. The implication often being that time traditionally dedicated to 'better activities' such as social play and physical recreation, is spent on anti-social, physically unhealthy and mentally numbing game playing, possibly leading to addictive

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GAMES CULTURES AND PLAY

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patterns of use. Though research is often oriented towards 'snapshot' results as opposed to tracking game-players over longer periods of time, longitudinal research does not show a long-term significant commitment to games over other activities.

Creasey's study (1986) of American 9 to 16 year-olds shows an initial rise in game playing time at the expense of other leisure activities when such a medium is introduced, but this soon decreased. Some research evidence suggests younger children (at primary or lower secondary levels) are more likely to play games regularly than children in the upper years of secondary school (Facer 2001, McFarlane et al 2002). Durkin (1995) concludes that what appears to be game-playing addictions are:

"...actually transient phases of excessive involvement rather than enduring dependencies from which the victim will find it very difficult to escape."

(Marsh 2001) analysed the activities of a sample of English families and discovered that 3 to 4 year-olds watched television for time periods far greater than involvement in any other 'leisure pursuit', including the playing of video games. Other studies support this, such as a European comparative study in 1997/1998 which showed that people aged between 6 and 16 spent on average 32 minutes per day playing electronic games, but 136 minutes watching television. Recent informal comment indicates an increasing awareness amongst the general public that games offer various forms of mental stimulation (BBC 2003), often in comparison to a perceived 'dumbing down' in the content of television programmes.

Gender differences in game players and the games they play have been increasingly discussed across a range of research and media during the last decade, but clear conclusions remain elusive. Circumstantial/informal evidence points to a substantial proportion of players of video games being female. It is difficult to identify any historical trends in gendered use of digital games, or how the attitude of boys or girls towards games change as children grow older. While games are no longer exclusively the preserve of teenage boys, it is still the case that the intense games players are more likely to be boys than girls, with figures varying between research reports according to the criteria used. Girls may play the same games as boys, but they may play them differently (McFarlane et al 2002). From an analysis of surveys Fromme (2003) hypothesises that girls generally lose interest in games as they age and use PCs for other uses, while boys still use PCs primarily as games machines. McFarlane (2002) surveyed English schoolchildren and discovered that:

"There is a tendency among girls to play games when they are bored or have nothing more interesting to do, whereas boys are more likely to play games as a first choice activity."

2.4.2 The effects of violence on game players

The issue of violence within games is an important one, as it crucially affects the acceptability of digital games in general and especially in the educational sector. Views on violence and game players are often polarised and entrenched, even amongst academic researchers.

However, the reporting on this issue often fails to distinguish between separate, though related, issues:

1 Are games 'violent' (and what is defined as 'violent'), and different to violence demonstrated in other media such as TV, cinema, comic books and literature?
2 Do 'violent' video games attract players who already possess violent behavioural attributes, or does the playing of 'violent' games make the games player more aggressive, or facilitate the transfer of violent acts from the game into their own lives?

A large number of studies and investigations have been carried out on the second issue (considerably less on the first) since the early 1980s. Much of this work comes from psychology and sociology, and focuses on the effects of games on younger schoolchildren in particular. The classical stance on this issue takes one of two positions:

1 The General Aggression Model, where "violent media increase aggression by teaching observers how to aggress" (Anderson and Bushman 2001).
2 The Catharsis Theory, where "video game playing may be a useful means of coping with (or releasing) pent-up aggression" (Emes 1997).

Reviews of the research and resulting literature produces an unclear picture with often contradictory conclusions on the effects of violent games on people (Dill and Dill 1998; Griffiths 1999). The underlying methods, results and conclusions of some studies which produced positive correlations between violent games and behaviour have been questioned in several reviews, including a brief filed by 33 scholars with the US Court of Appeals (Heins 2002).

The longevity of the effects of violent video games on people, and especially children, is questioned by several reviewers of the literature in this area, eg Bensley (2000). It is pointed out that the nature of research of this type is that results are collected during or shortly after the experiment, therefore not providing any data that can indicate the long-term effects of violent content or conduct within games.

Several researchers, such as Anderson and Dill (2000), note the increasing 'realism' within video games and state this as a reason for ongoing research into any linkage between such media and violent or aggressive behaviour. A widely discussed example is in the game Grand Theft Auto III, where the player is able to engage in sexual practices with a prostitute, then (in a separate act) kill her to retrieve the fee. Even with this example, there are proposals that this might be used as a resource to stimulate classroom debate on morality within contemporary culture (Gillespie 2002).

In summary, it is highly unlikely that the issue of games and violence will be 'resolved' (it should also be noted that parallel debates surrounding other media have existed for much longer). As well as having vocal proponents on both sides, the large amount of research (of varying quality, and often fragmented or out of context) has failed to reach a consensus. This is arguably because more reliable research would require researchers to study significantly more players, to explore other factors in violent behaviour and to

it is highly unlikely that the issue of games and violence will be 'resolved'

GAMES CULTURES AND PLAY

examine cause-and-effect relationships over long periods of time (years, instead of days or even hours).

2.4.3 Gender images

In Bryce and Rutter's (2002) key review of gender and gaming research it is noted that much of the discussion to date has focused around the content of the games, as opposed to deeper analysis of gender-specific motivation to play games. In other words, there is a focus on analysing the representations within a game, rather than on the experience of playing. Predominant in both mass-media coverage and research, for example, is the character of Lara Croft from the Tomb Raider series of games. The focal point of debate is whether Lara presents a positive role model or an unhelpful vision of the 'perfect woman' (Kennedy 2002). Research in the field that has looked across a number of different games, however, emphasises that there is "a general lack of female game characters, and the sexualised and stereotypical representations of those included female characters" (Bryce and Rutter 2002a; Dietz 1998; Greenfield 1994; Kafai 1996; Kinder 1996).

In considering the appeal of characters, there are concerns that females are alienated if they do not have identities in the game they can relate to. This has led to crude attempts by the gaming industry to attract female game players, by producing both hardware and software that reinforces classical gender stereotypes, eg pink games consoles, or games based around dolls (Cassell and Jenkins 1998).

In contrast, however, there is little debate on why males seem happy, as with the example of Tomb Raider, to assume a female persona or on the implications for young male players of the dominant models of male personality and appearance represented in games such as Grand Theft Auto.

Research into role-playing games, however, suggests that the question of gender and character identification may not be quite so straightforward as earlier commentators suggested. In role-playing games where avatars are created by players, for example, there seems to be a pattern that the first creations do indeed mimic the player's gender and age identity, but that later characters play with gender, age, ethnicity and sexual orientation. This play with identity is widely believed to be so common that experienced players do not assume an avatar reflects the player. In recent research with 16 to 28 year-old boys, they expressed no interest in young female avatars in the MMORPG (Massively Multiplayer Online Role-Playing Game) they were playing, assuming they would be middle-aged men in reality (Burn et al 2003). Bryce and Rutter conclude by arguing that:

"It is apparent that gaming practices are undergoing rapid social and technical changes and, at the same time, it is noticeable that gendered perceptions of gaming are changing... this is not a phenomenon unique to gaming and is consistent with the increased participation of females in other leisure activities."

Their conclusion is that gender relevance to games and gaming is a complex and rapidly evolving issue, and effectively needs to be researched within a wider social context than that of the gaming experience alone.

GAMES AND LEARNING

3 GAMES AND LEARNING

3.1 LEARNING THEORIES

In order to understand the potential role of mainstream games in supporting learning, we need first to ask what we mean by 'learning'. This is harder than it looks as there are multiple and evolving definitions of learning, with significant areas of disagreement both as to what it means to learn, and what forms of learning are valuable. The table below is adapted from Smith (1999) and defines key 'battle lines' in this debate.

These models view learning, as alternatively a process which leads to change in behaviour, change in ways of thinking, achievement of personal potential or development of capacity to operate within particular communities. Today, however, many researchers would argue that these processes are not mutually exclusive, indeed, one particularly pragmatic researcher in the field of games and learning argues that the model we apply to learning should depend on **what** it is that we are trying to ensure people learn at any given time (Prensky 2001):

"It seems to me... that there is another way of looking at all of this... and that is: 'How do they learn **what?**'... We must fit the 'how do people learn?' question to '**what** it is they are learning?' " (p80/82)

Given the state of the debate is seems clear that the potential roles and value of games in education will vary depending on

Aspect	Behaviourist	Cognitivist	Humanist	Social and situational
View of the learning process	Changes behaviour	Process entirely in the head of the learner (including insight, information processing, memory, perception)	A development of personal potential	Interaction/ observation in a group context, akin to an apprenticeship
Site of learning	External resources and tasks are what matters	Making connections in learner's head is what really matters	Emotion, attitude and thinking are important	Learning needs a relationship between people and environment
Purpose in education	Produce behavioural change in desired direction	Develop capacity and skills to learn better	Become self-reliant, autonomous	Full participation in communities of practice, ie you graduate from apprentice to craftsman

GAMES AND LEARNING

who is learning what, where, and why. With that caveat in mind, we now attempt to summarise how researchers in this field have described the role of mainstream games in supporting learning both in school settings and as part of children's leisure time.

3.2 LEARNING WITH GAMES OUTSIDE SCHOOL

In line with developments in learning theory, research that has examined children's self-motivated computer games play sees their learning as a process of participation in practice rather than a process of acquisition of facts or disconnected 'pieces' of information, ie 'doing' rather than 'knowing'. This takes a variety of different forms.

3.2.1 Learning 'competencies'

games can support the development of logical thinking and problem solving skills

Certain researchers have focused on children's interactions with individual games in order to attempt to identify 'what children have learnt' from playing. Since games are often characterised by a trial-and-error approach to overcoming challenges or obstacles, commentators have suggested that these games can support the development of logical thinking and problem solving skills (Inkpen et al1995; Higgins 2000; Whitebread 1997). Much of this research has focused on 'strategy or adventure games', which encourage students in exploratory quest-like scenarios with a high degree of control over their progress (Malone 1983; Russell 1990).

To date, however, it could be argued that much of this research relies on inference from the structure of computer games and psychological theory rather than direct and sustained empirical evidence. Recent studies at Futurelab have raised some questions as to whether children are in fact able to move from intuitive problem solving in the game to an understanding of effective processes for identifying problems and generating hypotheses and solutions in other contexts.

Other research has identified that children's use of computer games may play a significant role in developing effective use of computer-mediated information resources. Mackereth (1998) for example, argues that "there is evidence to suggest that familiarity with, and interest in, video games can influence children's confidence when using computers for more professional applications" and goes on to argue that children unfamiliar with video games:

"...may not develop the skills necessary to relate with electronic media, such as dealing with dynamic visual change, parallel processing of multiple streams of information and the ability to experiment in free-form, ill-defined problem domains."

Two studies of children's use of computers in the home argue that children's early interactions with computer games encourage them to develop a playful approach to computers (Downes 1998), which develops the expectation that 'trial and error works', and that linear progressive models for using computers (such as those characterised by worksheets or computer manuals) are often the least effective way of engaging with computer-based technologies (Facer et al 2003). This could have implications for the way that children approach computer-

based learning tasks, making it difficult to integrate these with other resources or activities. Massanari (1998) also records teachers' concern that gaming in schools may make it harder to engage children with the computer as a tool in more conventional learning tasks.

3.2.2 Learning to learn – new approaches to collaboration

Research into the wider context of games play indicates that, contrary to populist media opinion, games are often a facilitator to social, communication and peer activities. This has always been the case; in the early years of computer gaming, a 'playground culture' of discussing, swapping, buying and selling games emerged.

An early study (Greenfield 1984), for example, argued that half of all young people who spent time in video games arcades weren't actually playing games at all - rather they were using the arcade as a social gathering space. Fromme (2003) describes several surveys indicating that playing games with others is popular with German children, while Tobin (1998) argued that boys' gaming was not simply a process of 'playing the game' but embedded in social interactions.

Examination of the culture, and marketing, of video games reveals a wealth of material available to support games cultures and conversations. News and opinion on games comes from a number of sources, including games magazines, websites and online forums, encouraging reading and discussion amongst game players. The play itself may also be social; many games have a multiplayer option, with an increasing number being developed and marketed as a 'social experience' or 'party game'. Communication within games is becoming more complex; one prime example of this is Moto GP (Moto GP), an online (Xbox) motorbike racing game where, through a microphone, the players can communicate with those bikers who are close by on the track. The emergence of role-playing and online gaming as predominant genres adds to this culture of playing, if not always physically together, then in communication with others.

Until recently, there were few attempts to understand how mainstream games generate motivation, engagement and, arguably, learning experiences through the discussions and collaborations generated between players. One specific game, A Tale in the Desert (ATITD) is attracting particular interest amongst the research community. Described as a 'social experiment', it is an online game with no combat, only art, architecture and thought. There is also no end point to the game; the main underlying motivation to continue playing seems to be the social interaction.

Perhaps surprisingly, this replacement of a defined end goal with social interaction is becoming an increasingly common theme in games. The acclaimed Nintendo title Animal Crossing (AC) (named Animal Forest in the US) is set in a series of virtual towns, where players earn money in order to pay off their mortgage and accumulate possessions. However, the game opens up when the various communication systems are used, through which players can send 'post' to each other (in the game), as well as mail items, swap access codes, and visit each other's towns and houses.

Interactive communities often develop around mainstream games with or without

games are often a facilitator to social, communication and peer activities

GAMES AND LEARNING

developers' encouragement, as enthusiasts create websites, discussion boards and other communication environments to exchange information, experiences and even resources related to a game.

What these studies suggest is that one of the more interesting relationships between computer games and learning is not simply the interaction between the player and the game; rather, through processes of discussion, collaboration and reflection on games embedded in peer group cultures, children are learning how to play, and perhaps learn, in collaboration with others (Williamson and Facer 2003).

3.2.3 Learning to participate in practice

James Paul Gee's recent book (Gee 2003) 'What Video Games can Teach us About Learning and Literacy', has excited debate within games and learning forums. His key contention is that through informal games play, children learn to participate in what he calls 'semiotic domains', which are shaped by children's interaction with games texts and with each other. Gee uses the term 'semiotic domain' to mean a set of things that can take on meaning, eg words, gestures or pictures, used to communicate distinctive types of meaning, for example the specialist language used by doctors or the way graffiti artists use image. The following extract from a recent review of Gee's book (Williamson 2003) highlights the key arguments:

"Gee begins by describing games as 'multimodal texts' (texts that mix words and pictures) belonging to distinct 'semiotic domains' that employ a range of strategies contributing to new forms of literacy in which images and words, sounds, music, movement and bodily sensations are factors, and their recognition and production evidence of the learning of these emerging literacies. For Gee, video games are a family of semiotic domains defined by the characteristics of specific genres such as first-person shooters, fantasy role-playing games, real-time strategy games and so on, although these generic domains overlap just as they might in certain branches of science. Such domains are also, Gee points out, far from static objects defined only by their content, but rather they are predicated on lived, historically changing sets of distinctive social practices in which content is continually renegotiated and transformed."

Central to the argument about what video games offer to learning is Gee's assertion that semiotic domains are shared by groups of people, described as 'affinity groups', sharing knowledge, skills, tools and resources to form complex systems of interrelated parts. Within an affinity group, learners gain resources from fellow members that equip them to solve problems within, and perhaps outside of, the specific domain - and this is evidence of 'active learning'. For Gee, however the crucial aspect of this practice is 'critical learning':

"The learner needs to learn not only how to understand and produce meanings in a particular semiotic domain that are recognisable to those affiliated with the domain, but, in addition, how to think about the domain at a 'meta' level...(and) how to produce meanings that, while recognisable, are seen as somehow novel or unpredictable." (p23)

In other words, players must understand what they are doing and develop their

through informal games play, children learn to participate in 'semiotic domains'

comprehension of both a game's 'internal design grammar', or the ways in which its content is presented, and its 'external design grammar', or the ongoing social practices that determine the principles and patterns through which members of the domain recognise all the activities and practices which comprise it. Such systemic thinking, Gee argues, allows players to think about and critique games as systems and designed spaces rather than simply moment-by-moment playable environments. Such critical thinking is not only absent in many schooling practices, but goes unnoticed in much appreciation of what games can offer in terms of learning (Williamson 2003).

3.2.4 Games play and changing expectations of learning

What is key to most research into games and learning outside school, then, is a sense that playing computer games is encouraging young people to learn in different ways from those often in evidence, or explicitly valued, in the school setting (although it should be noted that much of this research is often driven by a desire to transform schools and sometimes paints a pessimistic picture of current practices). Marc Prensky, a leading advocate of games for learning (or training) argues that young people today expect different approaches to learning. The 'new vs old' tensions are summarised as:

- 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 friend vs technology as foe.

These ten characteristics of new methods of learning could be explained as young people developing the ability to process information **very quickly**, determining what is and is not of relevance to them; the ability to process information **in parallel** at the same time from a range of different sources; the familiarity with exploring information in a non-linear fashion – ie by 'jumping' through a range of different information resources, creating links rather than following a 'story'; the tendency to access information in the first instance through imagery and then use text to clarify/expand and explore; familiarity with non-geographically bounded networks of communication; a relaxed approach to 'play', viewing this as a valid activity and conceptualising the computer as primarily a 'play tool'; expecting intrinsic reward for activities; and having a model of **doing** in order to learn, rather than **learning** in order to do. Finally, these characteristics also include a relaxed acceptance of fantasy as a valid space of experience and a view of technology as a friend they have grown up with (Prensky 2001).

While we would wish to raise some notes of caution about any attempt to define an entire generation of young people as having a shared set of expectations and practices, this attempt to theorise new approaches to learning raises some interesting questions about how we currently conduct formal education in schools (Facer 2003a). In particular, Prensky's theories and the

playing computer games is encouraging young people to learn in different ways from those valued in the school setting

GAMES AND LEARNING

research outlined in the preceding sections raises key questions around the role of play in learning, the 'purpose' of education, the role of learning through activities perceived as intrinsically motivating to children, and the changing roles of children as learners.

The identification of any games as a site for 'playful' learning is repeatedly emphasised through the research literature, sometimes as an extreme opposition to children's experiences in school:

"Games are... the most ancient and time-honored (sic) vehicle for education. They are the original educational technology, the natural one, having received the seal of approval of natural selection. We don't see mother lions lecturing cubs at the chalkboard; we don't see senior lions writing their memoirs for posterity. In light of this, the question, 'Can games have educational value?' becomes absurd. It is not games but schools that are the newfangled notion, the untested fad, the violator of tradition. Game-playing is a vital educational function for any creature capable of learning." (Crawford 1982)

The notion of playful learning emphasises experiences such as experimentation, exploration, trial and error, imagination, roleplay, and simulation of experience suggesting that it might be possible to develop environments for learning based on these activities.

Finally, observing children's play of mainstream games in leisure time raises questions about the role we ascribe to children as learners in schools. The review of literature around children's social games play, for example, repeatedly highlights the ways in which children take on the role of teachers, providing advice, support, hints, tips and models of learning to other children. Perhaps more than any other aspect, this reconceptualisation of children as bearers of expertise, as capable of acting in the role of expert, raises serious questions about how we currently structure learning experiences in schools.

3.3 LEARNING WITH MAINSTREAM GAMES IN SCHOOLS

While the majority of research discussed so far has been concerned with what and how children learn in their informal playing of computer games, in recent years there have been a number of studies of the use of mainstream computer games in schools, intended to explore whether these games can have any role in supporting current educational objectives. Given the research above on the potential of games to support learning of competencies, collaboration and participation in practice, however, there are some significant tensions in evidence when introducing mainstream games into the school setting.

Three recent studies in the UK attempted to understand how mainstream games could be used in school. Each included surveys of predominantly UK teachers who had attempted, or wanted, to use mainstream games in the classroom (Becta 2001; McFarlane et al 2002; Kirriemuir 2002). The most frequently encountered perceived or actual obstacles were:

- it was difficult for teachers to identify quickly how a particular game was relevant to some component of the statutory curriculum, as well as the accuracy and appropriateness of the content within the game

KEY ISSUES IN DEVELOPING GAMES FOR LEARNING

- the difficulty in persuading other school stakeholders as to the potential/actual educational benefits of computer games
- the lack of time available to teachers to familiarise themselves with the game, and methods of producing the best results from its use
- the amount of irrelevant content or functionality in a game which could not be removed or ignored, thus wasting valuable lesson time.

The key disadvantage with mainstream games used 'cold' in the classroom was the amount of time taken for both the student and teacher to orient themselves within the game. Squire (2003) describes several sessions where historical strategy simulation games are used in a classroom, showing the considerable effort needed by the teaching staff to keep the students 'on track' within the game. This extra-topic play may or may not be valuable to learning generally but in either event the school curriculum has clear boundaries and objectives related to high stakes assessment – wandering beyond these boundaries is seen as wasting valuable time.

It is not only extraneous content that takes gaming outside the boundaries of the set curriculum. In the TEEM report (McFarlane et al 2002), teachers and parents recognised that games play can support valuable skill development such as:

- strategic thinking
- planning
- communication
- application of numbers
- negotiating skills
- group decision-making
- data-handling.

However, neither teachers nor parents were happy with the notion of playing games in lesson time since such skill development did not match the criteria assessed in high stakes national tests.

4 KEY ISSUES IN DEVELOPING GAMES FOR LEARNING

As far back as 1979, it was envisaged that the motivational aspects of digital games play might be used to support the acquisition of knowledge outside the game itself. Some of the distinctions between the resulting 'learning games' and 'mainstream games' are shown in Fig 1.

There are two key themes common to the development of games for education, namely:

- the desire to harness the motivational power of games in order to 'making learning fun'
- a belief that 'learning through doing' in games such as simulations, offers a powerful learning tool.

This section of the report will examine both these aspects of the design of games for learning, and ask whether they are well-founded objectives for design and development of digital game-based learning resources.

4.1 'MAKING LEARNING FUN'

The central ethos of traditional 'edutainment' software has been to make learning 'fun' although this is usually shorthand for the encouragement of engagement. One strategy is to introduce

children take on the role of teachers, providing advice, support, hints, tips and models of learning to other children

KEY ISSUES IN DEVELOPING GAMES FOR LEARNING

the debate on 'making learning fun' also often assumes that children do not enjoy learning

Mainstream digital games	Learning-oriented games
• widely known as computer and/or video games • developed solely for fun for the user and to maximise profit for the publisher • typically developed for PCs and video games consoles. Contemporary titles usually require the most powerful hardware currently available • increasingly developed in relatively simplistic format for mobile telephones • typically sophisticated in terms of graphics, interface and complexity; production budgets similar to small to medium sized film budgets • marketed directly to games players as being fun and exciting, graphically superb, the best game of its particular genre • uses high review scores in games magazines and tie-ins with other media as marketing aids	• historically known as 'edutainment', though negative associations with this word mean it is largely avoided by contemporary games publishers • almost exclusively produced for the PC; very few titles for the Mac or dedicated games consoles • games are more simplistic, are produced in a range of formats, eg Flash, Shockwave, Java, Visual Basic • most titles are designed for sole-user, offline play. • development costs are typically a fraction of those of major pure digital games • not typically marketed to users, instead marketed mainly to parents and teachers • marketed as being accurate, relevant to formal curriculum, developing specific skills/knowledge • uses recommendations from teacher, parent and educational organisations as marketing aids

Fig 1: comparison between mainstream and 'learning' games

content into a game-like scenario by stealth. In theory this is an attractive arrangement (Ahuja 1994):

"In conventional education, the learner is usually aware of the objectives of the activity he or she is engaged in. For children, such learning objectives often have little meaning... In interactive edutainment, on the other hand, the objective can be hidden while the activity appears driven by exploration, discovery and adventure. Children are attracted to such activity easily and will quite willingly go through a session, indeed, sometimes ask for it. A good example of this is the game Where in the World is Carmen San Diego, where the child learns history and geography in the process of being a detective."

Where in the World is Carmen San Diego has indeed been a successful exemplar of this concept, focusing on providing

elementary school reading, maths, geography, word, and critical thinking skills. Other educational games that have been shown to be successful in research studies focus on increasing a range of skills; for example, a piano tutor software package with overtones of video game elements requires concentration, a sense of timing, accuracy and rhythm (Sims 2001).

There are, however, some researchers who express disquiet at the amount of focus purely on motivation as a reason for playing games. For example, the authors of Project KID DESIGNER (Rieber et al 1998) write:

"...limiting the discussion to motivation is apt to designate the role of games as a form of educational 'sugar coating' - making the hard work of mathematics or language arts easier to 'swallow'. We take games much more seriously as we consider both their motivational and cognitive elements. Whereas most children play prepackaged games in school given to them by teachers, we are interested instead on the process of game design itself and how it can enhance learning."

And indeed today it seems that there are other concerns about the notion of 'sugar coating' education as a game, both in terms of motivation and in terms of the extent to which these resources actually achieve their educational objectives. To date, arguably, attempts to create truly engaging and effective learning games have foundered for the following reasons:

- the games have been too simplistic in comparison to competing video games
- the tasks are repetitive, eg continually doing sums, and thus quickly become boring and 'work'
- the tasks are poorly designed and do not support progressive understanding
- related to this last point, the range of activities is severely limited within the game, usually concentrating on one skill, or accumulation of homogenous content
- the target audience becomes aware that it is being coerced into 'learning', possibly in a patronising manner.

Finally, the debate on 'making learning fun' also often assumes that children do not enjoy learning. Yet much research evidence contradicts this, arguing that children do enjoy learning when they have a sense of their own progression and where the learning is relevant and appropriate for them. The 'learning by stealth' approach suggests that learning can only be enjoyable when it is unconscious. This is a significant area of contention, with some researchers arguing that reflection is an important part of the learning process, and others pointing out that we don't necessarily reflect on our own actions in day to day life, and yet still manage to learn from them (Prensky 2001). There seems less doubt however, that learning is at its most vibrant when it has relevance to the learner and is therefore truly authentic, regardless of the degree of consciousness (McFarlane 1997).

learning is at its most vibrant when it has relevance to the learner

4.2 FROM 'FUN' TO 'FLOW'

This focus on 'fun' and on 'concealing the learning' within educational games may, in fact, be a red herring. Instead, it might be worth returning to some early analyses that describes the pleasures of games play

KEY ISSUES IN DEVELOPING GAMES FOR LEARNING

we should understand the deep structures of the games play experience that contribute to 'flow'

as a 'flow' experience (Malone 1980; Csikszentmihalyi 1990). Prensky summarises this as:

"In the flow state, the challenges presented and your ability to solve them are almost perfectly matched, and you often accomplish things that you didn't think you could, along with a great deal of pleasure. There can be flow in work, sports, and even learning, such as when concepts become clear and how to solve problems obvious." (p124)

The conditions likely to induce the flow state are characterised by Malone as:

- the activity should be structured so that the player can increase or decrease the level of challenges faced, in order to match exactly personal skills with the requirements for action
- it should be easy to isolate the activity, at least at the perceptual level, from other stimuli, external or internal, which might interfere with involvement in it
- there should be clear criteria for performance; a player should be able to evaluate how well or how poorly (s)he is doing at any time
- the activity should provide concrete feedback to the player, so that (s)he can tell how well (s)he is meeting the criteria of performance
- the activity ought to have a broad range of challenges, and possibly several qualitatively different ranges of challenge, so that the player may obtain increasingly complex information about different aspects of her/himself. (p14)

Another commentator, reflecting on how to design engaging learning experiences, draws on these definitions to propose eight characteristics as essential (Jones 1998):

- task that we can complete
- ability to concentrate on task
- task has clear goals
- task provides immediate feedback
- deep but effortless involvement (losing awareness of worry and frustration of everyday activity)
- exercising a sense of control over our actions
- concern for self disappears during flow, but sense of self is stronger after flow activity
- sense of duration of time is altered.

Rather than aiming for an experience that superficially resembles leisure-based 'fun' activities, or one which attempts to conceal the educational purpose, it might be argued that we should understand the deep structures of the games play experience that contribute to 'flow' and build these into environments designed to support learning.

4.3 LEARNING THROUGH DOING

Simulations are one of the most popular types of games. Cruickshank (1980, p76) defined a simulation game as one "...in which participants are provided with a simulated environment in which to play", while defining simulations in their own right as (p75) "the products that result when one creates the appearance or effect of something else". Laurel (1991) claims that:

"Educational simulations (as opposed to tutorial and drill-and-practice forms) excel in that they represent experience as

opposed to information. Learning through direct experience has, in many contexts, been demonstrated to be more effective and enjoyable than learning through 'information communicated as facts'. Direct, multi-sensory representations have the capacity to engage people intellectually as well as emotionally, to enhance the contextual aspects of information, and to encourage integrated, holistic responses."

In other sectors of society, simulations are a recognised part of training. In the business and economic sectors, simulations are used heavily, as it is obviously better to lose 'virtual money' when a novice than a company's actual money. In medicine, simulations are used to test various treatments and to train medical staff without the need to cut open people, and in the military, simulations are extensively used (and increasingly converging with contemporary games technology) for quick and safe combat scenario training. The simulation field has its own long-established research community, grounded in a range of disciplines including mathematics, logic, philosophy and engineering.

Simulation games possess several attractive properties:

- they can be designed so the player receives instant feedback regarding the consequences of their actions
- the game controller or designer can add, remove or adjust various factors within the game
- compared to real-world training where materials and resources are used, a simulation is often a much cheaper option
- they enable dangerous actions to be undertaken in a safe virtual environment. For example, many people in the nuclear power industry train extensively on PC-based simulations.

However, this last example is pertinent to one drawback of simulations, in that they can rarely simulate every nuance of a real-world situation, and therefore (especially in critical industries) cannot totally replace real-world training. In the nuclear industry, it would be worrying if workers had no experience of a real nuclear reactor, and only simulated experience, before dealing with a crisis involving one.

In theory, as more powerful gaming technology and graphics capabilities become standard, so simulation games can become more realistic in terms of appearance and plausibility. However, this is not necessarily the case; real-world situations often involve long periods of inactivity, punctuated by periods of action, which does not map well onto the 'continuous flow' and engagement of a game. For example, Shenmue, a recent game for the Dreamcast, attempted to provide a realistic impression of living. However, the player spends some of the game at a bus stop, waiting for a bus to arrive (or not). Even though the game clock uses a speeded up version of real time, the game was still criticised in some quarters for being 'boring' during these sequences.

Simulation games are used increasingly in schools, though their take-up so far has been patchy. The Sim City game, where people design complex cities against a metropolitan budget, is used possibly more than any other mainstream game across the educational system and has been evaluated within classroom settings (Sim City 2002). Various research projects have analysed the use of this game in the

simulation games are used increasingly in schools

FUTURE DIRECTIONS IN GAMES AND LEARNING

until simulations can reliably re-create real world contexts, widespread adoption remains unlikely

classroom and consistently report favourably, showing that this (and similar) games enable group discussion and experimentation, and often facilitate a wider range of skills than immediately apparent from the game (in the case of Sim City, these include mathematical skills, urban planning, economics, engineering, environmental awareness and a host of others that can be mapped directly onto academic subjects).

Many other games on the market have simulation potential. For example, Super Monkey Ball, which involves rolling a monkey around a maze without falling off the sides, demonstrates (and allows experimentation with) the concepts of velocity, friction, acceleration and gravity. The increasingly popular genre of fishing simulation, in games such as Sega Bass Fishing, allows players to fish in a variety of locations. To be successful, the player needs to acquire various information (either from the manual or through trial and error), such as where the fish lies (deep or shallow, shaded or sunlit water) and which bait is most effective for which situation. Here the player, to be successful, has to learn of the 'ways of the fish'; this knowledge accumulation is continually examined/tested by playing the game itself.

However, titles involving monkeys and fishing are rarely if ever used in the classroom, possibly because the simulation and 'learning' possibilities seem less obvious (and the game appears to be more frivolous). One promising area for the use of simulation is science, but many products with apparent potential for this subject are inaccurate or simplistic and therefore not widely used (McFarlane and Sakellariou 2002). It remains difficult to predict how widespread simulation games will become in education at school level, but until simulations can reliably re-create real world contexts using explicit models that reflect those being taught, widespread adoption remains unlikely.

5 FUTURE DIRECTIONS IN GAMES AND LEARNING

5.1 WHERE NEXT FOR RESEARCH INTO GAMES AND LEARNING?

In this report we have examined research being carried out into the relationship between computer and video games and learning. There has, since the turn of the decade, been a much wider acceptance of the potential for such games in education. Traditional agencies are increasingly funding research for a number of reasons, including a desire to keep up with contemporary technologies; the hope of tapping in to the large commercial rewards of the gaming industry; and a small but increasing number of games-in-education success stories. This research is beginning to provide insights into how games might support learning both in children's day-to-day lives and in school.

In order to continue to develop understanding in this field, the following challenges now need to be acknowledged and met:

- developments with technologies that host computer and video games are moving at a rapid rate, in often unpredictable directions. This creates problems with even short-term research, where the nature of contemporary games can change significantly during the life of a research

project. Researchers and publishers of research will need to develop new and flexible approaches to conducting and communicating research rapidly

- the underlying and historical research covers a very wide arena of subjects, often containing competing, complex theories and positions. Educationalists themselves cannot agree on the concepts of education and learning; games researchers often have to learn about educational theory from the basics. To carry out rigorous research without making conscious or accidental assumptions in this field will require researchers to develop a good - and updated - working knowledge of games, learning and education (all rapidly evolving fields).

Despite these obstacles, research attention to the educational uses of mainstream games is both growing and gaining momentum, as evidenced by the number of publications, new academic research groups, and conferences dedicated solely to this field. It is increasingly obvious that a key element in maintaining this momentum will be an increase in the rigorous investigation of examples where computer and video games have been used in educational settings (both the school and home), in order to add to models of how people learn through gaming, and to provide justifiable cases for others to examine and follow.

5.2 WHERE NEXT FOR DEVELOPMENT OF GAMES FOR LEARNING?

There are three main directions we can now take to the development of computer and video games for learning:

5.2.1 The development of educational games

Traditional edutainment titles of the repetitive drill form embedded within games are still being produced and marketed to both schools and parents. While such 'drill and practice' is a proven principle of education and learning (McFarlane 1996), it is questionable whether such activities should occupy a significant part of the school day, where children have access to teachers, resources and more demanding and creative learning tasks.

There are, however, a growing number of examples of more imaginative software whose design is informed by educational theory, practice and research; Kar2ouche, the product of a collaboration between academic and industry partners using gaming technology, is one such example. The high profile successes of more rigorously researched and innovative software may well result in a greater proportion of educational games being developed which are based on higher order principles of education and learning.
Key to success in this area is likely to be the development of effective collaborations between both educators and those with an in-depth understanding of games.
At present there are a number of barriers to the games industry's involvement in such development, including:

- an awareness that producing software for this market will require different standards and requirements of content and game
- developing and mass-marketing just one product to a country or even a continent is relatively cheap; more localised requirements would push up the costs

research attention to the educational uses of mainstream games is gaining momentum

FUTURE DIRECTIONS IN GAMES AND LEARNING

- 'conflicts of image' may occur, where a games developer or producer would be producing both 'fun' or 'cool' games, and 'learning games'
- the almost total lack of video gaming equipment in schools, as opposed to homes, would require a massive investment in hardware for producers of console-based games.

5.2.2 Using mainstream games in schools

The use of mainstream computer and video games is both potentially very interesting and very challenging for formal educational settings. Numerous challenges surround the use of these games in a classroom setting; while some titles offer more scope for learning in the less constrained home context.

The key issues concerning the use of mainstream games in schools are:

- the many roles and requirements of the teacher in terms of training, understanding of the game, keeping the students 'on track' and troubleshooting. It is arguable that the role of the teacher, or mediator, is often as important as the game itself in terms of whether useful learning has taken place (Birmingham 2001)
- identifying games that may be successful or useful in a classroom situation. Here, educational funding bodies need to ensure that a 'chicken and egg' situation does not develop, where schools wait to view the results of the successful deployment of games in other schools before introducing the technology themselves. It is of increasing concern amongst the games research community that the use of such games in schools has now been widely discussed for a number of years, but has still failed to take place in any coherent manner
- cultural acceptance of games as media through which learning can take place. This is to a degree outside of the control of the educational sector, which must contest or deal with wider public perceptions of games
- compatibility with school hardware, licencing agreements, and arguably other software, eg allowing the player/user to easily port the financial results of a session on a business simulation game into Excel
- there is a need for developers of games (and other software) aimed at the formal education sector to consider the various stakeholders involved, and to consider both their needs (and how these may be fulfilled by the game) and their reaction to such a device .

Nevertheless, there is sufficient interest in the use of these games in the classroom to encourage further exploration in this area.

5.2.3 Using 'lite' versions of mainstream games

It is perhaps in a compromise between edutainment and mainstream games that the greatest potential to classroom-useable games lies. These would:

- have all unnecessary content removed (thus providing 'immediacy of learning')
- have their content and underlying rule base verified and tested by educational organisations

it is in a compromise between edutainment and mainstream games that the greatest potential lies

- include background/help/training materials for both the teacher/ motivator, and for students
- include curriculum-relevant tasks and content
- allow users to save at regular intervals
- be compatible with the original 'full' versions, so students could continue using the game at home
- be offered to schools on an attractive licensing system.

There is potential here for the games industry to develop an attractive, and low-cost, solution. As the code already exists for the games, development costs for the 'lite' versions should be very low. Marketing of the games would both open up new revenue streams, and extend the longevity of the original title, as students keen on the game purchase it for their own use. This does however assume that there are enough existing or planned games with sufficient content relevant to school-based learning to form a 'lite' version.

5.2.4 Developing game-based learning communities

The role of online communities associated with games in education is in its infancy and little related research or evaluation exists. The evidence from trials of games play in school does point to the importance of children's wider gaming culture. Discussion, reflection and planning are all collaborative activities that go on as children talk about their gaming, and plot their next session. Moreover they see this talk as a vital part of the fun of gaming. In recent years educational software developers have begun to pay more attention to the role of such interaction by creating online communities within which various 'educational games' can be found. Examples of this include the SparkIsland site, Grid Club and others. To date, however, these tend to be restricted to online communities 'surrounding' educational resources, rather than communities within which the games activities generate discussion and debate. Trends indicate that such virtual communities could contribute significantly to learning related to games play and, as such, this activity warrants research and evaluation.

The value of collaborative learning, and the role of computers in promoting such activity have been thoroughly researched. Whilst such collaboration cannot be assumed, and children have to learn to work together, computer-based activities can help in this process. How this collaboration translates into a multiplayer gaming environment and how these environments might be used to support learning, remain some of the most interesting areas for potential further research and development.

5.3 FINAL CHALLENGES

The central theme of this report has been a consideration of the case for developing, and using, computer and video games for educational purposes. In various idiosyncratic ways, and mainly isolated instances, such games and technologies are already being used in some classrooms (mainly in western countries). However, various issues relating to perceptions of games, relevance to curriculum, accuracy of content and suitability for use in timetabled classroom

virtual communities could contribute significantly to learning related to games play

FUTURE DIRECTIONS IN GAMES AND LEARNING

environments have so far prevented this becoming a mainstream activity in schools.

Before games can take on a meaningful role in formal or informal education, the education sector and the wider public and media need to better understand the potential and diversity of such 'tools'. In addition, the games development industry needs to understand the constraints on schools, teachers, parents and above all children of time, resources, and the requirements of curriculum and examination if games with more direct educational value are to emerge. Though a rapidly growing and maturing body of research is helping to develop a clearer understanding of the educational potential of games, there are as yet a small number of games that have a clear contribution to make to the educational agenda.

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END NOTES

(i) Various web-only publications contain stimulating and detailed research of high quality; for example, Fromme's paper on computer games as a part of children's culture (Fromme 2003). The archives of the mailing forums populated by postings from the key researchers in the field, such as the GamesNetwork (GamesNetwork) list, provide pointers to where contemporary thought, debate and research are heading. The problem, especially to researchers used to traditional information-seeking procedures, is of tracking down and validating such information.

For those interested in identifying such information, the following indexes are particularly relevant:

- The Game Culture website provides references to online and journal articles, and game books: www.gameculture.com/index.html
- The Digiplay website contains a searchable database of computer gaming books: www.digiplay.org.uk/books.php
- One particular site contains an extensive listing of publications concerning studies of role-playing games: www.rpgstudies.net/

In addition, several online journals (some peer-reviewed, and some not) dedicated to the study of computer and video games have recently started offering articles and references solely in this particular research domain. Three in particular appear to be good 'starting points' for further investigation: Computers in Entertainment (Computers in Entertainment), IJIGS (IJIGS) and Game Studies (Game Studies).

(ii) Fig 2: Stakeholders to consider in the development of games for use in schools

Actor	Affect
School child	Plays the game
Friends of school child	Peer pressure and group social behaviour can alter a school child's perception or use of the game
Teacher	Needs to know how to use the game to best effect. Will examine the game critically
Parent	Keen to see that their child receives the best and most appropriate education and teaching
Governor	Approves or oversees teaching practice within the school
Head teacher	Approves financial spending on items such as technology and software within the school
Technician	Can determine, or enable, what technologies and software can work within the classroom
Local funding body	Affects funds that the school receives
National educational body	Indirectly affects funds that the school receives; prescribes curriculum that the school follows
Media	Reports on school and education matters, which can affect the attitude of the various actors

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