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The relevance of video games and gaming consoles to the Higher and Further Education learning experience

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1. Introduction

Video games have been a significant form of entertainment since the early 1970's, appearing in a number of formats and locations: television-dependent consoles, portable games machine, games on LCD panels, amusement arcades and so on. Often, games technology has been combined with computing-oriented technologies, resulting in hybrid machines such as the ZX Spectrum, BBC micro series and the Amiga.

Traditionally, the video gaming industry has been cyclical in terms of profile, the number of machine owners and revenue. However, several factors including the emergence of cultural icons e.g. *Mario*, *Sonic* and *Lara Croft*, increases in game complexity and visual appearance, and massive sustained sales of games consoles such as the Sony Playstation and Nintendo Game Boy series, have led to video gaming becoming a significant part of contemporary culture since the mid-1990's. The video gaming industry generates revenue of between 18 and 25 billion US dollars per year (according to various estimates), with development costs, revenue and use/audience comparable (and often exceeding) that of the movie industry.

Games and games consoles have steadily increased in terms of technological, graphical and processing complexity and power. Contemporary video consoles are comparable to specialised PCs, designed towards a narrow range of applications. The last three years has seen an increasing number of studies and research into the use of video games, and gaming-oriented techniques, in learning and teaching scenarios and applications.

This report presents an overview of gaming consoles and a comparison of consoles and the PC. Benefits of games to learning and the learning environment are touched on, as is the use of games consoles in research and teaching. Issues pertaining to potential future applications of games and consoles to learning and teaching, especially through the enhanced functionality of consoles, are addressed. The report concludes with an overview of other gaming platforms, and a summary of key points and trends to monitor.

To assist in the compilation of this report, an email survey was undertaken of various computer and video game researchers in UK academia, and video game companies worldwide, in early 2002. This survey was useful in discovering trends, perceptions and examples of non-gaming uses of video games and gaming consoles.

2. Overview of contemporary gaming consoles

As of the beginning of 2002, the global games console sector is dominated by three companies: Microsoft (from the US), and Nintendo and Sony (both from Japan).

2.1 Microsoft

Microsoft is a new producer of consoles, though it has video game development experience through various software – the most well-known of which is the *Flight Simulator* series for the PC. In November 2001, Microsoft launched its Xbox console in the US; this was followed by launches in Japan (February 2002) and Europe (March 2002).

The launch of the Xbox was accompanied by a strong array of games, some highly critically acclaimed. The variety and quality of these "launch games" was a key factor in Microsoft selling 1.5 million consoles in the US between the launch date and the end of 2001. An average of over three games was bought per hardware unit sold; this was good news for Microsoft, as the Xbox follows the typical revenue model for a games console, where the hardware sells at a loss per unit but the manufacturer makes money on software royalties.

A range of peripherals will appear for the Xbox over 2002, including a DVD remote control, a HDTV (High Definition TV) cable and a broadband adapter.

It is evident from the amount of revenue Microsoft have invested in the Xbox (including a global publicity budget of some half a billion dollars), that the Xbox is viewed as a key Microsoft product. Long term arrangements with a variety of the leading games publishers indicate that Microsoft intend to become and remain a key games sector "player" for at least several years.

2.2 Nintendo

In late 2001, Nintendo launched its GameCube console in the US and Japan, with a European launch due in May 2002. Unlike the Xbox and the Playstation2, the GameCube will not be able to play DVDs, a disadvantage some industry commentators speculate may affect sales.

Nintendo recently launched the Game Boy Advance, a continuation of its Game Boy series which has sold over 130,000,000 units to date. Nintendo currently has no significant competition in the handheld gaming console sector, a position likely to continue for at least the next few years.

The Game Boy series has been host to a large number of games, the most well-known being the Pokemon series. The considerable revenue from this series and associated "spin-offs" such as Pokemon trading cards and movies, and the revenue from the Game Boy handheld itself, ensures that Nintendo has financial security for the foreseeable future, irrespective of sales of the GameCube and related software.

2.3 Sony

The Playstation 2 (PS2) was launched in 2000. Just as the Game Boy Advance can play games produced for previous models in the Game Boy series, so the PS2 has the ability to play games produced for the original Playstation. There are an estimated 300 titles in development for the PS2.

Sony is speculated to be working with Toshiba and IBM to develop next generation style semi-conductors which are likely to form part of the Playstation3 console; opinions differ as to when such a console would be launched, with most industry commentators predicting 2004 or 2005.

Sales of its current and previous Playstation models, an installed global base (and continuing healthy sales) of over 20,000,000 PS2s, royalties from games, and revenue from its other consumer divisions mean it is probable that Sony will remain a key console manufacturer for at least the first half of this decade.

2.4 contemporary games

Games have changed out of all recognition since the crude "bat and ball" simulations of the 1970s, or the arcade-originating *Space Invader* and *Pacman* games of later years. Many games, especially on newer consoles, feature very detailed graphics, complex interface systems, increasingly realistic character AI, intercut FMV (full motion video) scenes, orchestra complexity sound, multiplayer and online options.

There are an increasing number of specialist publications, such as *EDGE* magazine, that describe computer and video gaming developments. However, advances and complexity in games can only be really appreciated by play and interaction. Most people know someone who owns and uses a games console; in addition, many games shops (e.g. Game, Electronic Boutique) and music chains (e.g. HMV, Virgin) have consoles set up to allow members of the public to test and play video games.

2.5 demographics

The size of the video game industry is best illustrated by comparison with other cultural and entertainment industries. The following table [ILS] compares UK home entertainment spending over recent years:

	1998 (£M)	1999 (£M)	2000 (£M)
Cinema box office	565	643	632
Video and DVD rental	480	453	481
Video and DVD retail	944	882	1,104
Music software	1,861	1,944	2,018
Leisure software i.e. games	918	920	934

Projections of future leisure software sales in the UK show a gradually accelerating climb in revenue:

2000 (£M)	2001 (£M)	2002 (£M)	2003 (£M)
(actual) 934	891	1035	1171

This projected climb is due to the consolidation of the aforementioned consoles marketed by Microsoft, Nintendo and Sony over the first half of this decade. Recent sales point to these figures being conservative estimates.

2.6 online gaming

The PC has been heavily used as an online gaming machine since the first modems were marketed; consequently, many PC games are online-oriented. Titles such as *EverQuest* and *Ultima Online* involve many thousands of players being simultaneously logged on. One popular title in South Korea, a country with a high proportion of online game players, is *Lineage*; on occasion, over 200,000 people have simultaneously played the game online, usually from cyber cafés.

Due to the lack of online functionality in consoles prior to 1998, online gaming has, until very recently, been mostly PC based. An exception to this has been a selection of games on the Sega Dreamcast. In the latter stages of its short life, a number of titles were released that made use of an in-built modem. The most popular of these is *Phantasy Star Online* [PSO], which allowed people from around the world to interact in team-based quests. PSO included a novel speech mode: using a menu-based system, players selected “speech” which was translated into the language of the recipient. Therefore, people with different first languages, based anywhere in the world, could “converse” during the game in a relatively fluid manner.

Market experts predict that online gaming will be the largest area of expansion in the video games sector, an increasingly likely possibility considering the number of games under development that incorporate some sort of online facility. The Xbox, PS2 and GameCube all possess ports for modem/broadband connectivity, and all are developing the necessary infrastructure.

3. Comparison of the PC and games consoles

There are several fundamental differences between the PC and gaming consoles. From a technical perspective, consoles can be viewed as stable, closed environment, fixed specification PCs, usually running a stripped-down operating system that the end-user generally does not interact with.

3.1 cost

Games consoles, like PCs, reduce in price as they age. This tends to happen in jumps to coincide with launches of competing consoles. UK console prices are generally higher than those elsewhere in the world, sometimes by a factor of 30-50%. In the UK, the Playstation2 retails for around £200, the Xbox for £199, and the GameCube will launch at around £130.

3.2 network capability

Nearly all PCs bought for home or small business purchase contain a modem as standard.

The PS2 contains a slot for an optional broadband modem, and an optional USB modem from other peripheral developers. Sony is working with Telewest, and BT Openworld, to develop “net-based multi-player gaming systems”. Interestingly, both broadband and narrowband connections are in development, offering a price-based choice for PS2 owners [PS2 Online]. The Xbox is 10/100Mbps Ethernet broadband enabled, and offers an optional 56Kbps modem capability. The GameCube contains ports for broadband and 56K modem connectivity.

3.3 similarity to PC

The Xbox is the closest of the three main consoles, in terms of architecture, to a PC. The console contains a hard drive, on which game positions can be saved; however, the main function of the hard drive is for a game to temporarily store data – accessing the hard drive is quicker than reading a disc, thus reducing in-game data read delays. The hard drive is also used for players to save game “positions”.

3.4 processing power

A limited technical comparison between a PC and games console can produce an inaccurate picture. For example, it should be remembered that the primary (or sole) function of a console is to play a game, with no processor or operating system overheads committed to other tasks e.g. virus checking, printer or peripheral status monitoring. In addition, game players are mostly interested in the “best” games (defined by a fluid set of criteria), which through gaming history have not always appeared on the most technically advanced console of the time.

A limited technical comparison of the incoming generation of television-based video gaming consoles is thus:

	GameCube	Playstation2	Xbox
CPU	128bit 405MHz	128bit 294MHz	32bit 733MHz
Main RAM	24Mb	32Mb RAM	64Mb unified memory
Graphics RAM	16Mb	4Mb embedded on GS	see above
Graphics processor	128bit 202MHz	147MHz GS	300MHz Nvidia iGPU
Other processors		Input/output processor Signal processing unit	200MHz Nvidia MCPX
Memory Bandwidth	3.2Gb/sec	3.2Gb/sec	6.4Gb/sec

3.5 software range

Perhaps the starkest difference between PCs and games consoles is in the software and applications that are hosted by both. The PC is host to a wide range of applications, such as word processors, web browsers, office tools and database applications. Software on games consoles, until recently, has been almost exclusively games-oriented, with a niche of educational software [Gamerland]. Educational software is more common on PCs, which also hosts games (though these tend to be titles which make fuller use of the keyboard and other PC-centric peripherals).

However, as previously mentioned the Sega Dreamcast games console (1999-2002) shipped with an inbuilt modem and proprietary web browser, offering web and email access. Though the functionality of early versions of the web browser was limited, as it failed to recognise a number of plug-in media, the system offered a very easy to use method of online access for a cheap cost (currently £50-£60 for the hardware/software package).

4. Benefits of games and gaming consoles to learning

4.1 benefits of games

There are a number of small-scale investigations and commentaries e.g. [CMS] [TEC] concerning potential and actual benefits of video games in education. One study of particular interest to the UK is the Computer Games in Education project funded by BECTA [BECTA], where six computer games were used in the classroom to support National Curriculum learning. The study found that:

“...The over-riding appeal of the games in lessons was the way in which learning opportunities and skills were presented in the context of a situation attractive to young people. Championship Manager presented opportunities in the context of football, Age of Empires gave children control of cities and armies and The Sims allowed learners to build and furnish their own houses. This combination of interactivity with a familiar and yet novel situation, with clear and agreed aims for learning, seemed to be very effective.”

Though the study involved a relatively small number of games, it was able to derive a number of conclusions:

- ?? the role of the teacher in structuring and framing the activity of the learner remains crucial if learning outcomes are to be achieved. The teacher wishing to use games must know what kind of content particular titles offer. Also, the teacher requires some understanding of the controls, menus and skill levels of the game in order to use it effectively.
- ?? for some games and school contexts, working with specific and relevant elements or sections of the game may be more useful than using the game as a whole.
- ?? simulation games can offer learners sophisticated scenarios to support meaningful post-game discussion.
- ?? an imaginative and well-produced game may be flexible and complex enough to offer a range of educational opportunities.
- ?? teachers in the study found that use of the games could provide motivation, develop skills and encourage collaboration.
- ?? games have a significant advantage in that pupils receive immediate feedback on their actions and decisions, inviting exploration and experimentation.

Overall, there were obvious benefits to the use of components of video games that were relevant to the topic being taught. However, the workload of the teacher is significantly increased, as game evaluation, familiarity and objective planning is required.

Further research by BECTA has resulted in the identification of scenarios where games can contribute towards learning skill development, in addition to guidelines for capitalising on learning opportunities within games [BECTA infosheet].

Other studies point to computer and video games providing a range of benefits, though many indicate that these only occur when a game is used in a *relevant context to the learning activity or goal*. These benefits include:

- ?? at the most basic level (and over-quoted in the media), game players developing hand-eye coordination.
- ?? the development of strategic skills, through playing contemporary games which are increasingly complex and non-linear.
- ?? (against the stereotype of gaming as a socially isolating action) the development of team, social, communication and resource sharing skills through the playing of multi-player and (user) team-oriented games and simulations.
- ?? stimulating curiosity and encouraging experimentation in a safe “virtual” environment.

?? encouraging familiarity with technologies, and learning how best to use and manipulate software.

5. Incorporating games consoles into learning environments

5.1 television-based consoles

Rather than replacing PCs wholesale, a more likely scenario is the use of television-based consoles in a number of specific experiments, research, projects and services involving specific demographics of the population.

One example raised by respondents to the email survey was that of the elderly and housebound, for which there is strong anecdotal evidence of a steadily increasing use of games consoles. This is partially due to their low cost and simplicity of operation. Emerging consoles have the additional advantage of online connectivity for email (e.g. keeping in touch with friends and relatives) and Internet use. The providers of home-oriented learning courses designed for the elderly or housebound could consider the use of games consoles instead of PCs, as a low cost, easy to use alternative; in addition, technical problems would be reduced, saving repair costs and loss of learning time. Content and other materials could be provided either online, or on CD-ROM or DVD, with the course tutor and “students” keeping in touch via email and web-based forums.

One notable US example is that of *Lightspan* [Lightspan], which produces educational software for both the PC and Playstation console. This is used in the classroom and at home; many schools allow pupils to borrow a console in order to use the software at home. Not surprisingly, the use of gaming hardware as part of the educational process has caused controversy in some quarters. However, a large number of schools are using Lightspan, and evaluation shows improvements in some aspects of pupil performance.

Online facilities in consoles allow for extended game and communication-related possibilities. For example, a group exercise using a video game in the classroom could continue at home, as part of formal homework or purely because the pupil is enthused by the game. Online access would allow the pupil to communicate and exchange data with fellow pupils (possibly ones from the same class earlier, or ones from other schools using the same game as part of their lesson). Homework, in the form of satisfactory game completion, could be emailed back to the teacher for assessment and marking.

Several email survey respondents involved with the academic library sector highlighted the juxtaposition of online games (many thousands of online players simultaneously interacting in a complex manner, ease of use) with networked library services such as distributed bibliographic systems (long development times, limited simultaneous users, limited functionality, difficulty of installation, high maintenance overheads).

The feeling of academic respondents was that, before digital library systems could be developed that depended on the online capabilities or technologies of games consoles, formal research and prototyping projects were required to test whether the concept was feasible. Several aspects of successful online games and gaming were deemed worthy of investigation by the developers of such systems; these include:

- ?? simultaneous sharing of virtual resources or data by online players
- ?? player-to-player communication systems, such as in-game textual language translation
- ?? server performance during large-scale simultaneous user logins

5.2 handheld consoles

Handheld consoles offer a cheaper and quicker route for software development than television-based consoles. Consequently, a significant number of companies have been established that

create software for these machines (as development costs are of a smaller magnitude as those for television-based consoles). The only significant handheld console is the Game Boy series. Hardware – not approved by the console manufacturer – for developing software is extremely cheap, and consists of blank cartridges and a PC-based cartridge writing peripheral; supporting software is often shareware or freeware in nature (and varies in quality accordingly).

The ease of development for this console, in addition to the ease of converting or emulating software developed for other platforms, has resulted in a large community of solo, unofficial developers [GB dev] [GBA dev]. Most of the resulting software is entertainment-oriented, or demonstration-quality in nature; however, a few applications are of more relevance to education and learning, such as the multilingual electronic book [eBook] reading application for the Game Boy Advance. Arts students in the US have also experimented with producing electronic artwork on this device.

As well as ease of development, another attractive feature of the Game Boy Advance is the large number of hardware units being sold (see section 2.2). This is partially due to the cost (currently £70), long battery life, large collection of games, and the ability of the GBA to use software produced for previous Game Boy models. With the average age of GBA owners being much younger than that of television-based consoles, a significant proportion of schoolchildren are, or soon will be, owners of the console. This produces interesting possibilities for low-cost learning-software development, though games developers indicate that the official involvement and encouragement of Nintendo would be a critical factor in educational developments for this machine.

6. Games consoles as research tools within academia

6.1 Examples of uses of consoles

Increasingly, software originally developed for games is being used for commercial or academic purposes. For example, one emerging application is that of building design and representation, using software from FPS (First Person Shooter) simulations such as Unreal [Unreal], or the Quake [Quake] series of games.

Games consoles are occasionally used in psychology research. For example, at Bangor University Frances Garrad-Cole [Garrad-Cole] has used the Playstation 2 to assess children's competence at visual processing, as part of an analysis into the development of attention.

As mentioned elsewhere in this report, consoles are often being reverse-engineered for non-gaming purposes by enthusiasts. An increasing number of student projects are using consoles for unconventional purposes. For example, the final year project of one student involves developing a web server to run on a Game Boy Advance [GBA web].

6.2 Consoles in game-related courses and research

A growing number of courses, and modules within courses, concern games programming, design and related disciplines. Most of these courses and modules exist within computer science, engineering and media departments in newer universities [Maddock]. Respondents from heads of UK computer science departments to the email survey indicate that several more courses will commence, or are under consideration, over the next two academic years.

Console manufacturers and games companies provide resources to support both teaching and research in a number of these universities; such resources include:

- ?? funding to support research, from student projects to full PhDs [Mocap]
- ?? software and development kits to assist in console programming skills acquisition
- ?? gaming consoles for teaching and research purposes

A report by the DTI [DTI report] uncovered strong links between many academic games courses and research groups, and local games development companies; such links usually initiated the donation of resources. However, one of the major suppliers of gaming resources to date has been Sony [SCEE], which has donated Playstation consoles and development resources to a number of academic departments through its Yaroze [Yaroze] programme. Correspondence with the manufacturers of the Xbox [Xbox] indicates that a similar programme is likely in the near future, so people can gain experience of developing for this particular console.

7. Games consoles within the technical infrastructure of HE/FE institutions

One niche application of a games console is that of a cheap “mono-function” machine within the network infrastructure of a university. For example, practically any computer can be turned into a web server [c64], and a games console is no exception. Technical staff in at one UK university computer services unit have used a Dreamcast games console – in an unofficial capacity, due to a lack of licensing agreements and management perceptions of gaming machine – as such a device, through reverse-hacking the system and installing linux-based server.

One far more likely application of games consoles is in scenarios where the openness of the PC presents problems. In correspondence, technical (network and systems) staff at a high profile East Midlands university indicated that PCs left in unsupervised areas were often used for illicit purposes. Stand-alone sole-purpose PCs, installed as e.g. printer stations, email terminals, or visitor intranet stations, were often used for other applications, such as online gaming, or external web use. It is regularly discovered that people ran web servers from such PCs; one person was discovered to be running a web-based business! Safety precautions were often drastic; for example, OPAC terminals in the university library for a time had their ALT keys painstakingly unsoldered to prevent users from bringing up dialog boxes and command windows.

Here, one of the strengths of the PC (its openness, ease of access and manipulation) is also one of its weaknesses. It does not require great technical skills to manipulate or interfere with all but the most secure of PCs. A games console, through its lack of open operability, potentially offers a more secure solution. In addition, the simplicity of operation of such consoles, as well as their relative stability when compared to PCs running certain software/operating systems, means that they require far less technical support and maintenance. Also, the lack of a hard drive (or a hard drive that is difficult to access) could be of benefit in some circumstances e.g. where a machine is required for some network-based purpose that makes it vulnerable to virus attack.

At least four UK universities, such as Abertay in Dundee, have carried out trials using the online functionality of the Dreamcast console to e.g. allow students to access their email and the Internet, in a low-cost, easy to use and simple to (technically) maintain manner. These trials have been without the support of the console manufacturer, and did not lead to a larger or more formal use of the console within the institution. This was usually due to a combination of factors, such as the limited functionality of the proprietary web browser, the lack of a hard drive to save data, and the lack of a printer or similar peripheral. Some of these factors are overcome by the additional functionality and features of newer and incoming games consoles, thus providing more realistic uses of consoles in system-based scenarios.

8. Games, gaming consoles, and future learning and teaching

8.1 expanding non-gaming functionality

As previously indicated, games consoles are currently used, almost exclusively, for playing games. There are two main reasons:

1. the business model for most consoles is based around healthy sales of games. Most console manufacturers sell their devices at a clear loss per unit, and make a profit through royalties on games licensed for that machine(s). The business model is therefore oriented around encouraging console owners to purchase as many games as possible, thus recouping losses on the hardware and generating an overall profit per machine.
2. game publishers (the companies that commission games, and deal with distribution and marketing) are focused almost entirely on games production. This is partially because of the mixed reputation of educational (or *Edutainment*) software in the past, and partially as these companies tend to commission “low risk” genre-driven software. This latter point is similar to the situation in the music and film sectors, where innovative ideas are less likely to be funded than ideas similar in content – or style – to previously successful products. Hence, we have replica pop music groups, film sequels, and video games that are similar in nature to previous best selling titles. The genres of football and formula 1 motor racing simulations are particularly notorious for the abundance of near-identical games.

Several email survey respondents from both games companies and academia indicated that the large-scale emergence of official educational software on video game consoles would only happen if one of the following occurred:

1. console manufacturers altered their business model so that it was not based on the need to sell many (games) software units per console unit.
2. a publisher takes a risk and commissions a high profile, high-quality educational title for a games console, with pedagogic input from teachers and graphical input from games designers, that was marketed widely. Should the title prove to be successful, then other publishers would inevitably follow in significant numbers.
3. a collaboration between educational funding bodies, educationalists, and either games publishers and/or console manufacturers resulting in experimental educational console-dependent software that is verifiably beneficial to the learning experience.

8.2 console functionality developments

It has become increasingly clear that games console manufacturers are following two paths of console development:

- ?? the console as a “pure” games machine – the Nintendo GameCube is such a device, without additional functionality such as a DVD player. It is being marketed aggressively as a games machine, as opposed to an entertainment system.
- ?? console at the centre of an entertainment hub – the Playstation2 and the Xbox are promoted more as multi-functional entertainment machines, though still with game-playing at the core. Continued industry speculation points to their successors offering greater functionality and becoming a more central “several entertainment units in one” device in the home.

The console manufacturers are all making online gaming a key component of their hardware and software strategies. The application of online gaming technologies to education will depend largely on:

- ?? the functionality of proprietary games console browsers
- ?? the ability to download, store and manipulate data located on the Internet
- ?? the ease of development of non-gaming applications

Significantly (especially if the scheme is widened, and Microsoft follows suit with the Xbox), Sony has marketed a number of Playstation2 linux development kits; these include a monitor, keyboard, linux and a hard-drive [PS2 linux]. Officially, the kits are released in order to increase the number of people who can gain experience of developing games-oriented applications for the PS2. However,

it is obvious how such a system could be used to develop (or port) educational, academic or technical applications to the console.

8.3 educational application developments with consoles

The increase in online teaching and learning offers a wide range of possibilities for console-based teaching and learning – if relevant software is developed. Watts [Watts] illustrates a number of benefits of online learning, in addition to examples where the medium is more cost-effective or practical. For example, an electronic student can “blow” circuits in circuitry simulations, manipulate genetic material, or combine chemicals – in a safe and “virtual” environment using virtual materials that are infinite and freely replaceable.

In addition to this simulation-based approach, games can also distort (or suspend) the laws of physics. For example, biology teaching packages can allow a student to speed up the growth of a plant or an unborn child or animal, in order to see how the entity develops over time. Civilisation-based games can illustrate, through “time acceleration”, how one political decision can impact all areas of society over time.

Progress – much of it unofficial – with the Game Boy Advance handheld console is moving so rapidly that new developments are announced on an almost daily basis. The low cost and ease of development means that this is the most likely platform to see (at least unofficial) educational developments, such as the conversion of learning materials that are mainly graphically abstract in nature into GBA cartridge format. The fact that the GBA is portable (and far more robust and cheaper than a laptop) has led to informal speculation from teachers about developing software for outdoor activities, such as to support field trips, museum trips, camping and countryside expeditions e.g. electronic “I-spy” in the countryside.

9. Other gaming platforms

It is naive to concentrate solely on (video) gaming consoles, when other gaming platforms with mass-appeal are emerging. These technologies need to be monitored; the mass-use of those that succeed will influence the skills, use and familiarity of interactive technologies for significant proportions of the population.

Video game installations are appearing in a variety of unconventional places, such as in the headrests of cars for rear passengers, on the backs of airline seats, in hotel rooms, on digital watches and mobile phones. Basically, where there is space for a video or LCD screen, so the potential to offer games and gaming experiences exists.

In the UK, despite widespread marketing, WAP (Wireless Application Protocol) has so far not become a widely-used mobile phone medium. Instead, and generally not predicted by industry experts, SMS (Short Messaging Service) has become the most popular non-vocal use of such devices [SMS].

Mobile phones are, however, a growth market for the games industry; development costs are relatively small in comparison to games on the PS2, Xbox, PC and GameCube. One early limitation of mobile phone gaming is that of the small monochrome LCD screens, which severely hamper the graphical features of any game; keypad inadequacies presented another barrier. However, handsets are starting to emerge with higher definition colour screens, and Java-based functionality. The next mobile phone generation should bring greatly increased bandwidth, and the ability to play more complex mobile-to-mobile games. The rate of growth of this part of the games sector is, however, difficult and almost reckless to predict; industry speculation differs greatly.

House or office-based phones, with additional functionality such as email, web and game playing, are a relatively new area in the UK. One product that has caught the attention of many games

players is the Amstrad e-mailer, which allows people to send email, web surf (with some limitations), and download and play ZX Spectrum games on the LCD screen for a small fee [e-mailer].

Interactive TV is another area where games are gaining a foothold. In the UK, take-up of Interactive TV has steadily grown, with games being one of several forms of entertainment available through this media. Though these games are not of contemporary games console quality, they are proving to be popular [iTV] and an increasingly lucrative source of revenue. Interactive TV offers new possibilities; for example, many people are able to “play alongside the contestant” in quiz shows such as “Who Wants To Be A Millionaire”.

10. Summary

The emergence of video games and gaming consoles as a mainstream form of culture and entertainment has resulted in a rapidly developing range of specialised electronic devices. Many of these devices are relatively cheap, high powered, reliable, and owned by large proportions of the population. An increasing number offer, or will offer, Internet access (initially for online gaming purposes), which presents opportunities for remote information access, teaching and learning scenarios. Games themselves present, in relevant contexts, possibilities for learning and teaching support, and are used as such in an increasing number of classroom scenarios (mostly in the US).

There are a number of video game-related trends and developments which HE and FE need to monitor. These include:

- ?? the ease and openness of developing non-gaming applications for games consoles e.g. “pure” educational software.
- ?? independent software developments on relatively low technology gaming platforms e.g. handheld consoles such as the Game Boy Advance.
- ?? the use (in terms of numbers, method of use in games, non gaming use e.g. web browsing) of the online facilities incorporated into games consoles.
- ?? developments of software (for games consoles and the PC) that incorporate the best features of educational and gaming techniques.
- ?? the relevance of aspects of video game development to academic courses and research.
- ?? developments in game design, such as graphical techniques, plot and character development, user interface design, and making the player learn, that can be incorporated into the development of learning and teaching materials.
- ?? demographics of video games e.g. the proportions of people in different social strands who own consoles and games (and are therefore familiar with them), as opposed to other devices and systems such as Interactive TV and PCs.

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