Digital games and learning gains

John Dowell, University College London

> By the year 2000, one in four American homes was estimated to have at least one Sony Playstation (www.sony.com)
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> In a recent survey of American children, a half of all respondents were found to have a video game machine in their bedroom (www.mediawise.org)

Digital games are compelling because they reflect essential aspects of our cognition and culture. They reflect, for example, our ability to respond rapidly and adaptably to uncertain visual stimuli, our use of stories as a primary knowledge representation and our ability to spontaneously infer narratives for given situations; their design also reflects the excitement we experience at resolving threats and challenges, and our pleasure in discovering novel situations and in shared activity. The success of digital games is explained by very many factors, but primarily by the emotional responses they evoke, most obviously: determination, relief and pride; curiosity and wonder; fear and aggression; and, humour and joy. Games designers produce these emotions through the design of characters and their capabilities, rewards, obstacles, narrative, competition and opportunities for sharing with other players. The possibility of exploiting the same techniques to produce effective learning experiences has resulted in the genre of educational games for use in formal educational settings as well as in the home. However the separate question remains as to whether digital games that are designed and used for pleasure have a learning gain. This is the question considered here.

Learning is an outstanding feature of our cognitive and cultural lives and most of it occurs through experience rather than through formal instruction. Experiential learning, 'learning by doing', is spontaneous, continuous and can be unlimited. Learning is therefore not delimited by the bracketing of games into those designed for pleasure and those designed for education. Learning continues with digital games for fun; even 'twitch-style' action games, whose narrative amounts only to 'kill or be killed', are capable of producing learning of some sort. The question asked here then, is not so much whether we learn with games designed for pleasure but what we learn and what value we give to that knowledge; this naturally leads to asking what do we want to learn and what is it possible to learn with digital games.

What we have already learnt about playing digital games

As with so many other interactive digital technologies, the rapid emergence and transformation of digital games has been well in advance of research attempting to understand it, let alone influence its direction; it has rather been a case of invention taking advantage of opportunity. Our understanding of the effect digital games may have on users and how games produce that effect is limited. Much of the available research was conducted well over a decade ago and is in need of renewal given the pace of game development and uptake; research into games still lacks a useful framework (Gredler 1996). The focus of research into non-serious digital gaming has been almost exclusively on social, cultural and emotional effects (Squire, 2003). The perspective taken has been invariably of negative learning, in other words, on how negative knowledge may be acquired through playing digital games. The possibility that positive knowledge may be acquired, (i.e., positive learning) has received negligible attention.

In contradiction to most of the rhetoric on the subject, researchers have largely been unable to find a relationship between playing digital games and negative social learning. Most surprisingly, given the violent nature of so many games, research has even found difficulty in

establishing clear evidence that players learn to be violent. Some research (Calvert & Tan, 1994) has found that games increase violent thoughts and feelings, but the finding has not been replicated by other research (Graybill et al, 1987). Some researchers have found that children exhibit more violent play after playing digital games but no more so than after watching television (Silvern, 1987).

Evidence for negative socio-cognitive learning is mostly equivocal. Sakamoto (1994) reported a small correlation of video game playing with social abilities in regard to empathy, complexity and abstractness. However the study design did not control for baseline socio-cognitive abilities amongst children choosing video games. Sakamoto also found no correlation between computer use in general (for word processing or programming) and socio-cognitive abilities. The image of the solitary and socially disengaged player has also been displaced by recognition that game playing is often a highly sociable activity. Children meet with each other to play, and even when not playing, their talk can be about games. Mitchell (1985) studying the use of computer games in families even believed that digital games were bringing families together to play in the way that board games once did in the era before television.

Digital games have often been seen as a threat to creativity and to learning to be creative. Provenzo (1991) argued that players are in effect consuming a product of a designer's imagination and therefore are not using their own imagination. Similar to criticisms made about television, digital games have been claimed to reduced childrens' opportunities for developing their own creativity. This criticism has been influential among media pundits (MediaScope 1996) and echoes anxieties which were once expressed about the social effects of television. Presumably the same criticisms could also be levelled at books. However an alternative and more plausible view sees culture not as a commodity but rather as a form of communication and knowledge which is assimilated, developed and re-expressed. In this view digital games are a form of popular culture similar to film or television and they make a similar use of a heritage of storytelling.

Given our interest in experiential learning from gaming, it is significant that no effect of digital games on childrens' academic performance in school has been detected. Because of the intervening factors and the methodological challenges of relying on survey data and establishing controls, finding a clear result in this area is particularly challenging. Only in the most extreme cases where children spent more than fifteen hours in a week on digital games was an effect evident relative to their peers (Lin and Lepper, 1987), yet even here obsessive game playing behaviour is likely to correlate with poorer academic performance rather than being its cause; any effect may also simply be due to the displacement of homework activity. So the knowledge and skills acquired from non-serious digital games are quite distinct from those acquired in formal education, to the extent that educational assessments are unable to detect a benefit or disadvantage of gaming.

In fact the clearest evidence of learning with digital games is of their positive effect on perceptual and motor skills. Cognitive neuroscientists Green and Bavelier have reported in *Nature* that playing action video games produces a general improvement in visual skill. In other words, the perceptual learning which occurs when playing a game generalises to new situations outside of the game; this is a relatively rare finding in perceptual learning where learning effects are routinely found but do not transfer beyond the training task (Green and Bavelier, 2003). The authors speculate that digital games are able to modify attentional 'bottlenecks' within the cognitive architecture, that they increase processing speed in perception, and that they teach better multi-tasking at the central executive level of cognition.

The possibilities

Games were of course an established pedagogical method before the digital age. Games based on simulations, often using paper and pencil, have been used in settings ranging from military academies to business schools. Now this method is being adopted more broadly by schools and

universities exploiting the learning potential of games such as *SimEarth*, *Civilization* or *Hidden Agenda*. The learning gains from digital games therefore need to be examined in relation to the learning value of gaming as a general pedagogical method.

In a survey of three decades of studies of gaming as a pedagogical method, in the main no difference was found in learning outcomes between games and conventional instruction (Randel et al, 1992). Some 38 of 67 studies showed no difference on objective measures of outcomes, 22 showed a clear advantage for games and only three showed an advantage for conventional instruction. Differences in retention and learner interest were examined across subjects including social sciences, mathematics, languages, logic, physics and biology. Mathematics learning showed the greatest benefit from gaming, whilst thirty-three out of 46 social science games showed no difference in outcome with classroom instruction. Gaming appeared to be of greatest benefit when very specific content could be targeted. There is consistent evidence that games increase motivation to learn and interest in a subject (Druckman, 1995), but it is less clear how this translates into learning gains. The vital effect of motivation is also suggested by an earlier meta analysis which found that the longer the game lasts, the less effective will be the learning gains (Dekkers and Donatti, 1981).

Randel‘s conclusion that gaming has a limited impact on learning drew on many studies involving pre-digital gaming technologies. It is a reasonable conjecture that increasing technological sophistication can unlock the learning potential of digital games. Towards advancing the progress of digital games into the classroom, there has been much enthusiasm for understanding the properties of digital games and exploiting those properties through design (Jonassen s& Land 2000; Squires, 2003). In particular the experience of learning through playing digital games has been characterised through its contrasts with learning in a classroom, for example key features of digital games have been described (Bowman, 1982) as follows:

- players control the pace and schedule of their activity.
- players are actively engaged in dynamic and varied activity
- players are able to rehearse their knowledge and skill until they have achieved a level of achievement of the game
- players are able to explore the environment and consequently become more knowledgeable about it.
- players often work together, sharing and trading play knowledge
- achievement is measurable and criterion based. Every student can reach an individual state of “mastery” over the game.
- games are played for the intrinsic reward of playing them

By contrast, classroom-based learning was described as giving learners little control over the pace of their learning, as giving little control over what they learn in terms of its range, depth and progression, as offering limited feedback, and as making students into passive recipients of abstracted knowledge. This is a poor caricature of learning in the classroom but it nevertheless appears to capture important cognitive properties of what it is like to learn through gaming, with the implication that learning environments, digital or otherwise, should provide clear goals and challenges, allow collaboration, give control over learning to the learners, and incorporating novelty into the environment. Allowing for individual choice in the fantasy presented in digital games has also been shown to affect motivation and performance significantly (Cordova and Lepper, 1996).

So the possibilities for using digital games in formal educational and training situations are being explored by educationalists, continuing a longer tradition of using games as a pedagogical method. Researchers are attempting to understand how the particular qualities of digital games

can be exploited educationally. In the main the tremendous advancements in gaming technology over the last decade have not been exploited for educational uses. Recent gaming developments in interactive fiction and online role play games such as *Second Life*, with their socially based microworlds and elaborate character development, offer entirely novel possibilities for learning in a structured educational setting. The central question here to which we now return is what learning could be said to come from playing for fun.

Taking advantage of experiential learning

Digital games are arguably the most advanced and elaborate digital media available to personal users and embody an accumulated design knowledge about interface, aesthetics, and interactivity. Games have historically exploited whatever was technically possible in software, whether it is building online communities, creating elaborate graphical worlds, or allowing synchronous collaboration between remote players. The latest games represent very diverse play genres which, in addition to action-based games, include simulations, strategy, role playing, sports, puzzles, and adventure games. Good game design across these genres immerse users in rich interactive digital microworlds. Gamers can fly a jet fighter or direct the growth of an entire civilization (*Civilization, Age of Empires, Alpha Centauri*); they can bring up a family (*The Sims*), create a new species (*Creatures*), explore rich interactive environments (*Shenmue*), or engage in fantasy/role play (*Final Fantasy VIII*). The most recent games markedly extend the concept of game. The diversity and complexity of games is taken to another dimension by the collaborative play which is possible with online game, which can now involve large numbers of other players. *Second Life* does not exhibit many of the characteristics associated with a game, and certainly no winners or losers in the conventional sense. Players interact with each other through animated avatars in this virtual environment, creating and using social structures.

These new generation digital games have a far greater complexity than ever was possible with pre-digital games. They typically require players to discover what are the objectives are of the game, what are the rules governing play and how to implement or achieve the objectives. Critical information may be deliberately withheld from players. Players are confronted with a bewildering array of information through which they must divine the hidden logic of the game to find order and meaning in the visible chaos. This ambiguity demands considerable concentrated learning and is one of the reasons why digital games may often appear baffling. Players must often explore in a hypothesise-and-test manner to make sense of a game, which explains why some games can take up to forty hours to complete. Some games use historical scenarios represented in considerable depth allowing players to develop their knowledge of the represented events. Players must learn how to operate the interface controls to implement their play and eventually can become expert in using these controls. The same is not the case with their strategic level play. Digital games cannot be played simply by solving each challenge as it arrives, building a strategy for resolving the problems is vital to balance the demands of competing interests and limited resources. Playing a digital game is increasingly becoming an exercise in planning and managing complex tasks: “It’s about finding order and meaning in the world, and making decisions that help create that order.” (Johnson, 2005). The research which can substantiate the experiential learning of these skills with digital games has yet to be done, but the value of those skills is beyond doubt.

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