

# Making sweet music: The Educational Use of Computer Games:

Cand. Psych., PhD Scholar Simon Egenfeldt-Nielsen  
Center for Computer Games Research  
IT University of Copenhagen, DK-2400 Copenhagen  
game.itu.dk

The area of educational computer games is not yet well defined but there are recent attempts at rehabilitating the field. However, sidestepping classic edutainment is not an easy task. Edutainment have since the 1970s used a classic formula for producing educational computer games based on learning theories with problematic assumptions given our current knowledge of how humans learn. This article outlines the characteristics of edutainment, traces its historical development, and introduces some of the most important research into the area so far.

Finally it is attempted explained what a new approach to educational computer games should include if it wants to avoid the pitfalls found in the current market as well as the research carried out up till now. The article concludes with a third generation perspective on educational use of computer games. The third generation perspective implies an inclusive triangle of player, culture, and computer game to understand the full spectrum of educational use taking as its starting point the activity 'educational use of computer games'. It is not sufficient to look at the player as more motivated, game culture as a collaborative endeavour, or computer games as complex devices that automatically transfer knowledge to any player. We need to look at how each of these elements helps constitute the activity educational use of computer games<sup>1</sup>.

## THE LEGACY OF EDUTAINMENT

To this point computer games with 'educational' features have not fared well in the marketplace. The 'educational' content tends to come at the expense of the gameplay and control is taken out of the hands of the player... Game buyers (as opposed to concerned parents) are wary of edutainment.

(Leyland, 1996:1)

Edutainment is potentially a broad term which covers the combination of educational and entertainment use on a variety of media platforms including computer games. The term edutainment is quite elastic as a lot of games are put into this category, and game companies are so inclined as to strengthen the appeal for parents, although the brand edutainment is not as attractive anymore (Buckingham & Scanlon, 2002; Konzack, 2003). Parents appreciate the combination of entertainment and education, preferring play that teaches

---

<sup>1</sup> This chapter focuses specifically on the research on educational use of computer games, and do not engage with the relevant adjoining area of educational use of simulations and games. This area does have a number of reviews that can serve as a solid starting point (Bredemeier & Greenblat, 1981; Clegg, 1991; Dorn, 1989; Randel et al., 1992; Van Sickle, 1986)

children something. This links well with the common rationalizing of children's play pursued by adults as argued by Sutton-Smith & Kelly-Byrne (1984). There is a distinct tendency for both educators and parents to cast play in developmental terms. Children should not just play for the sake of playing, but in the process preferably nurture other skills. This wish for rationalizing play is extended to edutainment and used for creating a new market. Although, there are theoretical good arguments for using play for learning they are often glossed over in edutainment (Egenfeldt-Nielsen, 2005).

Edutainment is inspired by behaviourism and to a lesser degree cognitivism and socio-cultural theory. It tries to focus on simple computer games and the delivery of straightforward information to the player. Many early popular educational computer games have a different understanding of learning and do not fit the current label of edutainment. However, the expression of edutainment slowly becomes narrower extending from a conservative approach to learning. An exploration of edutainment's nature is important as it will show the characteristics and problems of current edutainment titles, and point forward to new forms of educational use of computer games. In that sense edutainment to some degree serves as the villain in this article rather than a generic term for learning, education and computer games.

On an overall level, edutainment is a subset of educational computer games that is easily recognizable with a clear reward structure in the game separate from the educational experience. In *Math Blaster!* the players must shoot down the right answer and on success one's balloon will move towards a needle. The player that first pops the balloon wins. It is assumed that a constant shooting of the balloons will automatically lead to a conditioned response no matter the learning, context or previous experience. In the recent *Math Missions Grades 3-5: The Amazing Arcade Adventure* by Scholastic, you earn money for every correct answer. This money can be spent on buying arcades and you even get to run the arcade. Here the rewards are used as a way to push the learning forward without really being related to the learning experience as such. There is not really any connection between the arcade games and the math questions. It is not different from a mother promising the noisy child an amusement trip if he will be quiet and do his homework.

We should not think of edutainment as a fixed genre but rather as different titles which share some problematic assumptions about motivation, learning theory, learning principles and game design while being produced, marketed and distributed differently than commercial computer games. The characteristics are outlined below:

- *Little intrinsic motivation:* Edutainment relies more on extrinsic motivation through rewards, rather than intrinsic motivation. Extrinsic motivation is not really related to the game but consist of arbitrary rewards, for example getting points for completing a level. Intrinsic motivation would for example be the feeling of mastery from completing a level.
- *No integrated learning experience:* Usually edutainment lacks integration of the learning experience with playing experience, which leads to the learning becoming subordinated the stronger play experience. The player will concentrate on playing the game rather than learning from the game. One example is the skipping of

educational text in a game and going straight for the mini-games located in the game universe – the split between educational part and games is dominant.

- *Drill-and-practice learning principles:* The learning principles in edutainment are inspired by drill-and-practice thinking rather than understanding. This means that you will constantly get arithmetical problems like 2+2 memorising the results, while not necessarily understanding the underlying rules that make  $2+2 = 4$ . Training rather than understanding is the defining experience.
- *Simple gameplay:* Most edutainment titles are built on a simple gameplay often from classic arcade titles or a simple adventure game with a world you can move around in. There is few innovations in the gameplay used in the genres, although there are of course exceptions.
- *Small budgets:* Edutainment titles are often produced on relatively limited budgets compared to commercial computer games and with less than state-of-the-art technology.
- *No teacher presence:* Edutainment never makes any demands on teachers or parents. Rather edutainment assumes that students can simply be put in front of the computer with the edutainment title and learn the given content or skills. There is no required teacher or parent guidance, help or involvement.
- *Distribution and marketing:* They are distributed and marketed differently than commercial computer games for example through bookstores, supermarkets, schools and family magazines.

Edutainment games probably do teach children bits of things (see figure 1 below), but mostly edutainment is simple in its facilitation of learning experiences. Rote learning in relation to spelling and reading for pre-school and early school children may see some gains from edutainment. However, edutainment does not really teach the player about a certain area, but rather lets the player perform mechanic operations. Training rather than learning. This will lead to memorization of the practiced aspects but probably not a deep understanding of the skill or content – it will be parrot-like not really grasped by the student and although this may work for some limited areas, like spelling and reading, this is a quite limited scope. In general, the parrot-like learning will result in weak transfer and application of the skills as it is not fundamentally understood, but only memorized as a mechanic action in the game environment (Gee et al., 2004; Jonassen, 2001; Schank, 1999). Improvements within the area taught by edutainment titles may show up on assessment, which formulates questions that are very close to the aspect learned, but is more doubtful if the assessment strays away from the specific aspect learned.

There is also common agreement that edutainment fails to integrate the learning with the computer game. Hence, a change of focus in the learning experience from the educational part to the game part. This results in weak learning experiences especially if you consider the time-on-task issue – the player won't spend a lot of time on educational experiences, but rather gain a lot of game experience. (Brody, 1993; Fabricatore, 2000; Facer et al., 2003; Vandeventer, 1997). In general, the information in edutainment is fed to the player in chunks separated from the games like in the Swedish game *Chefren's Pyramid*. Here you start with a presentation of Egyptian history and an overwhelming amount of facts that you scroll through and *sometimes* read. Then you start the 'game', where you walk inside a Pyramid finding different puzzles or small games like *Backgammon* – but these game dynamics have no connection to Egyptian culture, which the game is supposed to teach the player about. Most players will learn to play *Backgammon* though.

Edutainment is also criticized for supporting a superficial and problematic construction of learning in the new generations. As Okan (2003:258) asks "Should learning be fun?" This is supported by Healy (1999) and Kafai (2001) who ask whether we in our eagerness to revolutionize learning are undermining the very foundation for learning. Students need to be able to endure frustration during learning and stay on track despite problems. This is argued to be rare in edutainment titles and that may be right, but it is certainly not an inherent feature of computer games in general. Frustration and challenge is central in Gee's (2004) account of the learning qualities of the commercial computer game *Rise of Nations*.

The dynamics found in edutainment are also apparent in the e-learning industry, where low budgets, high amount of mediocre contents and craze for ease of use has led to the lowest denominator. There is put little weight on the quality of titles as the market is unable to evaluate the products. The decision-makers buying the e-learning tools are not the ones using them (Aldrich, 2003). This parallels the parents' choosing the educational titles for their offspring. Although a few parents will sit and play the educational title with their children, they are still quite detached from the playing and most engage superficially with the computer game (Buckingham & Scanlon, 2002).

Overall the shortcomings of edutainment has led to an overall negative attitude towards edutainment titles. There is, to put it mildly, widespread scepticism towards almost any aspects of edutainment. The gameplay, learning principles and graphics are all criticized heavily by users, both children and parents, really starting with the mergers in the early 1990's (Brody, 1993; Buckingham & Scanlon, 2002; Egenfeldt-Nielsen, 2005; Leyland, 1996).

## LEARNING OUTCOME FROM EDUCATIONAL USE OF COMPUTER GAMES

Looking at the research into educational use of computer games, one is struck by the quite optimistic tones from most studies but one should be cautious. Indeed many of the studies have severe flaws related to researcher bias, short exposure time, no control group and lack of integration with previous research. Overall, this undermines the strength of each study – the incremental learning process within the research field is as of yet still weak.

Author(s)	Year	Genre	N	Subject	Results
Levin	(1981)	Action	-	Math	Computer games are motivating, engaging and ultimately successful in teaching children the planned math concepts. Computer games may be especially suitable for teaching different ways of approaching math that caters for individual

					differences.
Dowey	(1987)	Puzzle	203	Dental health	Children learn best from a combination of teaching and computer games but although they learn about dental hygiene this does not transfer into change of everyday practice.
McMullen	(1987)	-	37	Science	The drill-and-practice computer game was not found to have any effect on the learning, neither short-term nor long-term. However the students playing the computer game indicated that they thought they had learned more.
Jolicoeur & Berger	(1998a; 1998b)			Fractions Spelling	You learn from computer games, but educational software is more effective.
Wiebe & Martin	(1994)	Adventure	109	Geography	They find that there is no difference in learning geography facts and attitudes between computer games and teaching activities not on a computer.
Sedighian and Sedighian	(1996)	Strategy	200	Math	The learning outcome is critically affected by teachers' integration of computer games and traditional teaching, but computer games prove highly effective.
Betz	(1995)	Strategy	24	Engineer	Finds that computer games increase motivation and learning
Thomas et al.	(1997)	Adventure	211	Sex education	Students learn from playing the computer game both on specific knowledge items and in self-efficacy.
Brown et al.	(1997)	Action	59	Diabetes	The study finds that children can learn about diabetes from computer games changing everyday habits.
Klawe	(1998)	Adventure	200	Math	Computer games are effective in teaching students about math.
Adams	(1998)	Strategy	46	Urban geography	Computer games increase motivation and teach students about the role of urban planners (affective learning)
Noble et al.	2000	Action	101	Drug education	Students taught by the computer games, found the experience motivating and wanted to play the computer game again.
Turnin et al.	(2000)	-	2000	Eating habits	Computer games can teach students about eating habits and lead to significant change in everyday habits.
Feng & Caleo	(2000)	-	47	Spelling and math	Children that played computer games learned better than peers not using computer games, mostly in spelling.
Becker	(2001)	Action	-	Program.	The study testifies to the increased motivation in connection with computer games. Games are found to be more effective and motivating than traditional teaching
Lieberman	(2001)	Action		Asthma, diabetes,	A review of a number of research projects that support that you can learn from computer games.
Rosas et al.	(2003)	Action	1274	Reading and maths	Computer games increase motivation, and there is a transfer of competence in technology from using the computer game.
McFarlane et al.	2002	-	-	All subjects	The study finds that teachers in general are sceptical towards the learning of content with computer games. However the learning of general skills was appreciated.

Gander	(2002)	Strategy	29	Program.	The study finds that computer games are effective for especially teaching specific knowledge.
Squire et al.	(2004)	Simulation	96	Physics	Students using the simulation game performed better compared to the control group.

**Figure 1: An overview of the studies into the effectiveness of educational use of computer games**

The figure above presents an overview of quantitative studies on educational potential of computer games. It should be stressed that most of the studies use computer games as the sole teaching style. The studies examine whether computer games work as a viable supplement primarily during school time. Overall one must say that the current findings are actually more positive and promising than educational use of traditional games (for an overview see Egenfeldt-Nielsen (2005)), but it is hard not to be sceptical as the method flaws are severe. We can certainly say that you learn from computer games but the support for saying something more valuable is weak. The current studies do in most instances not compare computer games with other teaching styles, which is really the ultimate test.

In the following I will focus on the studies that cover strategy games and have some relation to teaching of social studies, mainly to illustrate the problems with existing research within the area. Both of the studies examine *SimCity 2000*, which have from its release been emphasized as ripe with learning potential (Becta, 2001; McFarlane, Sparrowhawk, & Heald, 2002; Pahl, 1991; Prensky, 2001).

The most interesting study on the effectiveness of using computer games for teaching is by Betz (1995). It is characterized by operating with a control and experimental group, actually comparing educational use of computer games with a different teaching style. The participants in the study are freshman students in an engineering technology course with one class assigned as experimental group; another freshman class is the control group. The computer game is presented as a computer simulator and two weeks before the reading assignments the experimental group gets a head start to ensure they play the computer game. Both of the groups get the same reading and test after the study. The correlation is tested with the Mann-Whitney test, and show that the experimental group does better in the test ( $p < 0.05$ ). The survey results from the experimental test were also quite positive as most students preferred the computer simulator, used it more than the reading, enjoyed it more, tended to discuss it with friends, thought the computer game was less hard than reading and found that the computer game helped them understand the reading. Interestingly, they also found that the computer game helped them understand the reading. Overall the positive aspects of the experience were overwhelming and support educational use of computer games.

The study, however, does have some methodological flaws on closer examination that seriously challenge the validity, reliability and generalization of the results to commercial computer games in general. First of all, the manual for the computer game is quite dense on the topic urban planning. It actually points to relevant reading, which hardly can be said for most commercial computer games. The extra material point to the game designer Will Wright's special interest in providing an educational experience. The random sampling is problematic as it consists of classes, which are not normally considered acceptable as a random sampling (Coolican, 1994). A class may have different established dynamics or other hidden variables which influence the results. These problems are aggravated in Betz's study as little effort is done to examine if there exists basic differences between the classes, especially a pre-test exam to establish the academic level would have been critical to raise the scientific quality. This is, however, often hard in an educational setting and a pre-test could also steer the students in a particular direction, challenging the validity of the study.

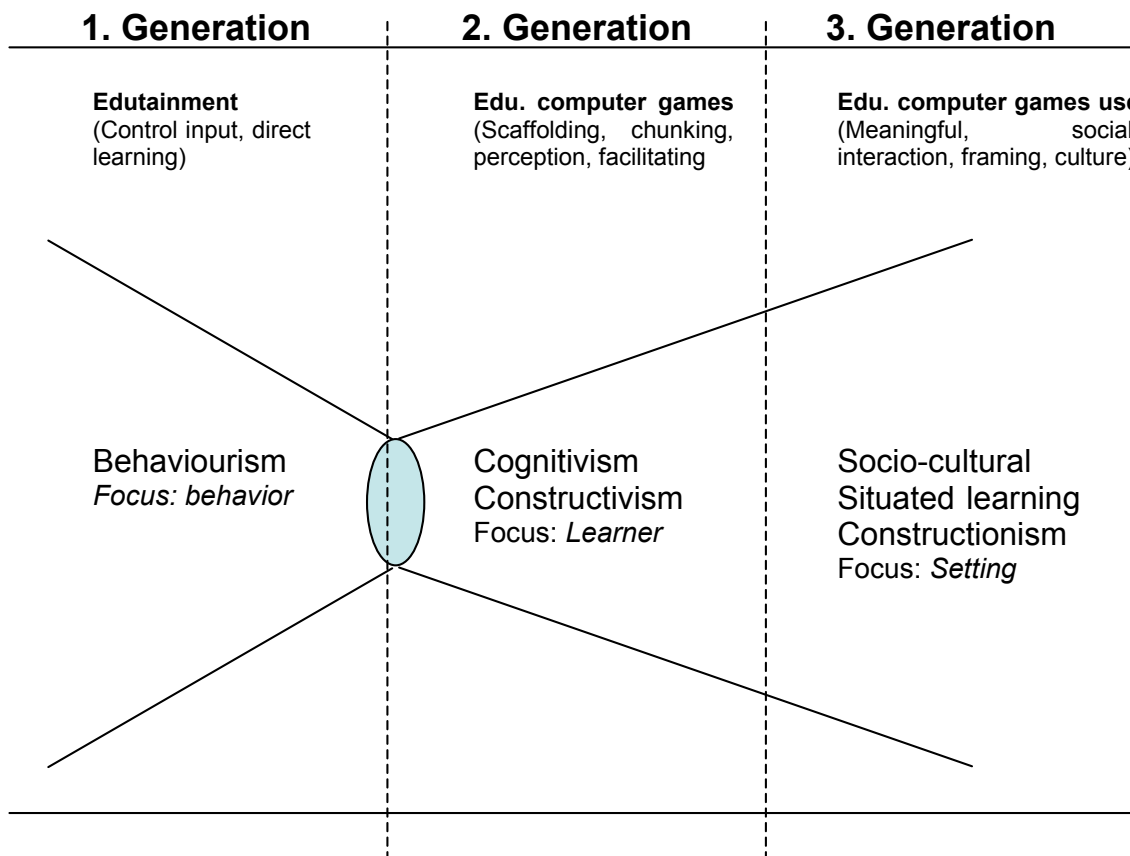
The most serious flaw is however that the results don't really measure computer games compared to other teaching, but rather as an extra supplement. The experimental group and control group get the same reading, but the experimental group also plays the computer games. It is hardly surprising that extra time-on-task within a somewhat related area that also sparks discussion and interest, increases learning. On the other hand, it is of course interesting that you can get students to spend more time on a subject through computer games. Still, the real question is whether the time used on the computer game is sufficiently legitimised by increased learning, compared to other teaching methods. In other words the study doesn't show us how big the impact of the computer games is and it fails to show if the same result could have been obtained by reading an extra hour instead of playing. Of course the extra hour provided by the computer games would perhaps never emerge with traditional teaching material.

In another study of *SimCity 2000*, Adams (1998) also finds support for using computer games within the subject urban planning. Adams takes a more structured approach to teaching, with the computer giving the students different experiments to carry out in the game. The outcome of the study was evaluated through essays and the student's preference. The course was voted a favourite project by 48% of the students, outperforming the 8 closest projects significantly. The study, however, lacked more systematized evaluation of learning with a control group or pretest-posttest set-up. All the problems in Betz's study reported above, also holds true for this study. Although the study finds the students do learn from computer games, it is quite unclear what the exact effect is and how it compares to traditional teaching forms.

Overall the 20 studies in figure 1 above overwhelmingly support that you learn from computer games, and that most students appreciate games in education. However, the studies in general do not ask the hard questions concerning educational use of computer games. None of the studies actually compare computer games to other teaching methods or activities, to examine whether computer games are worth the initial efforts in learning the interface, setting up computers and other practical problems (Egenfeldt-Nielsen, 2004). Most of the studies are one-shot studies with a lack of knowledge of the characteristics of computer games and with weak connections to earlier research. We need to raise the bar for educational use of computer games: Asking under what circumstances do we learn and how does computer games compare with other learning experiences. It is hardly enough to establish that we learn from computer games as this is essentially true for any activity we engage in. The real question is what computer games offer that set them aside from existing educational practice.

## **LEARNING THEORIES ACROSS THE DIFFERENT AREAS**

The idea with the figure below is to identify different generations view on educational use of games, which entails the positioning of different learning theories, the historical progression evident in learning theories, and the connection with educational computer games' use (Figure 2).



**Figure 2: The model shows the different generations characteristics, and how they emphasis different learning theories.**

The starting point is a focus on learning through changing the behaviour of students. Behaviourism is interested in directly observable actions split into a stimuli and a response. The theory claims that you learn by practising skills and contents through reinforcements and conditioning. There is little initial interest in differences between learners, settings and material learned. Through practice you will learn the correct response to a certain stimuli. The 1st generation perspective corresponds with the dominating expression of edutainment, which assumes that learning occurs when you unreflectively practice a skill enough times. Some edutainment titles try to differentiate between learners, and take into account different ways of learning, which points towards 2nd generation educational games. Research from a behaviourist perspective within educational use of computer games tend to focus on extrinsic motivation opposed to intrinsic motivation. In extrinsic motivation you get a reward for engaging in an activity, and are not motivated by the activity by itself. The actual research from a strictly behaviourist perspective is somewhat limited, but the approach is rampant in dominating edutainment titles (Brown, 1997; Lieberman, 1997; Lieberman, 2001; Prensky, 2001, 2004).

In the cognitivist approach, the learner becomes the centre of attention. The cognitivist approach criticizes the automatic relation presented in behaviourism between stimuli and response. They see the focus on behaviour as skewed, neglecting other important variables, namely the cognitive structures underlying the responses, which are crucial for gaining intrinsic motivation and meaningful learning. People have underlying schematas that represent what have been learned. When students approach a new task you need to take into account that they have different schematas. These schematas make up limits and options for

each learner that can be addressed through scaffolding information, chunking information, multimedia information, and present material in ways that correspond with cognitive abilities. There are limits to the information you can process, better ways to solve problems and different ways of perceiving information. I call this the 2nd generation approach, using computer games for educational purposes. Here you will try to build educational computer games that present information in ways that are appropriate to this specific learner, and open up different ways of approaching the same topic. The multimedia experience is central for providing these different ways to a topic, and multimedia also supports the player's progression at his own speed and ability. Scaffolding information becomes even more central than in the previous generation. The 2nd generation also differentiates itself from the 1st generation through its interest in meta-skill: Problem-solving, analysing, perceiving, spatial ability etc. The trend was apparent from the mid-1980's to the mid-1990's where eye-hand coordination, problem-solving and other cognitive skills were heavily researched. It is still found in many educational computer games and educators' preference for the problem-solving abilities that can be harvested from playing computer games (Klawe, 1998; Klawe & Phillips, 1995; Malone, 1980; Malone & Lepper, 1987a; Malone & Lepper, 1987b; McFarlane et al., 2002; Whitebread, 1997).

Constructionism is the bridge between 2. and 3rd generation with a strong focus on the learner, while involving the setting. For constructionists, the artefacts in the environment can be used to mirror the learning processes from the outside. At the same time, the artefacts provide a platform for exploring new material, mostly from an individual perspective, but also in collaboration. This is further stressed in situated learning and the socio-cultural approach, where the learning process is seen as mediated in a social context. In a social context physical artefacts (or tools) are a good facilitator for learning new concepts, as they give a shared starting point and potentially show the student new ways to proceed (Wenger, 1999; Wertsch, 1991, 1998).

The construction of knowledge, as meaningful through your orientation in a social context, becomes paramount in 3rd generation. Instead of conceiving content, skills and attitudes as residing with the user, knowledge is transferred to culture, tools and communities. Wenger (1999) talks about the interplay between participation and reification, where participants will continuously construct a community through the negotiation of meaning. To support this negotiation reifications are constructed like school culture, agendas, conception of computer games, hi-score tables etc. You learn new things by participating in these communities and appreciating and negotiating what counts as knowledge, skills and attitudes. It is worth stressing, that in this perspective the educational use of computer games ties much closer to the surrounding culture. When you use computer games in schools, the students will draw on a variety of cultural capital to make this experience meaningful. This process is also reciprocal, as the renegotiation of computer games in schools will also lead to new cultural capital being generated, which is useful outside of school.

The 3rd generation approach doesn't exclusively focus on the specific computer game, but looks at the broader process of educational use of computer games. It stresses the key role of providing a social context that facilitates asking the right questions and going the right places. Here, the teacher becomes central as facilitator for balancing the educational computer game experience as connected to school, other practices and drawing on other practices to expand the scope of the computer game from 'just' playing to learning. The third generation is less interested in the actual content in computer games, but focus more on the students' engagement with the computer game (Egenfeldt-Nielsen, 2005; Gee, 2003; Squire, 2004).

The discussion above highlights the need for a broad learning approach to computer games consisting of several layers. We need to appreciate, how content, skills and attitudes are not just transferable, and neither merely a question of interaction between player and computer game. On the other hand this interaction may very well be severely limited by the concrete implementation of the computer games, its contents. An active, interested and strong community that thinks of computer games as its preferred way to learn history, will not get very far if the computer game does not scaffold information, has a problematic interface, assumes existing knowledge nowhere easily found and bombards the students with overwhelming amounts of information. It will certainly also play a role with the basic reward structure, habituation and connecting experience in time. Students will be steered in directions by being awarded points, getting a hi-score and beating other players. They will learn that 'sword' refers to the object sword every time they pick up a sword object with text below it. And they will slowly be less impressed by what this specific educational computer game has to offer them. The strong audiovisual universe will also serve to create a stronger learning experience.

It should be stressed, that each generation is carried forward to the next, but de-emphasised. The learning mechanisms in behaviourism are still at play in next-generation use and so are the ones from cognitivism but they are conceived in a broader overall frame. Hopefully, a more inclusive understanding of educational use of computer games will bring us beyond the current lack of innovation in the market – letting research inform a new generation of strong educational game products.

## References

- Adams, P., C. (1998). Teaching and Learning with SimCity 2000. *Journal of Geography*, 97(2), 47-55.
- Aldrich, C. (2003). *Simulations and the future of learning*: Pfeiffer.
- Becker, K. (2001). Teaching with Games - The Minesweeper and Asteroids Experience. *The Journal of Computing in Small Colleges*, 17(2), 22-32.
- Becta. (2001). *Computer Games in Education Project*. Retrieved 19. January, 2005, from <http://www.becta.org.uk/research/research.cfm?section=1&id=519>
- Betz, J. A. (1995). Computer Games: Increase Learning in an Interactive Multidisciplinary Environment. *Journal of Educational Technology Systems*, 24(2), 195-205.
- Bredemeier, M. E., & Greenblat, C. S. (1981). The educational effectiveness of simulation games: A synthesis of findings. *Simulation & Games*, 12(3), 307-331.
- Brody, H. (1993). Video Games that Teach? *Technology Review*, 96(8), 51-57.
- Brown, S. J., Lieberman, D A, Gemeny, B A, Fan, Y C, Wilson, D M and Pasta, D J. (1997). Educational video game for juvenile diabetes: Results of a controlled trial. *Medical Informatics*, 22(1), 77-89.
- Buckingham, D., & Scanlon, M. (2002). *Education, edutainment, and learning in the home*. Cambridge: Open University Press.
- Clegg, A. A. (1991). Games and simulations in social studies education. In J. P. Shaver (Ed.), *Handbook of research on social studies teaching and learning*. New York: Macmillan.
- Coolican, H. (1994). *Research methods and statistics in psychology*. London: Hodder & Stoughton.
- Din, F. S., & Caleo, J. (2000). *Playing Computer Games versus Better Learning*. Unpublished manuscript.
- Dorn, D. S. (1989). Simulation Games: One More Tool On the Pedagogical Shelf. *Teaching Sociology*, 17(1), 1-18.
- Dowey, J. A. (1987). Computer games for dental health education in primary schools. *Health Education Journal*, 46(3).
- Egenfeldt-Nielsen, S. (2004). Practical barriers in using educational computer games. *On the Horizon*.
- Egenfeldt-Nielsen, S. (2005). *Beyond Edutainment: Exploring the educational potential of computer games*. Unpublished PhD, IT-University of Copenhagen, Copenhagen.
- Fabricatore, C. (2000). *Learning and Videogames: An Unexploited Synergy*. Unpublished manuscript.
- Facer, K., Furlong, J., Furlong, R., & Sutherland, R. (2003). 'Edutainment' software: a site for cultures in conflict. In R. Sutherland, G. Claxton & A. Pollard (Eds.), *Learning and Teaching Where Worldviews meet*. London: Trentham Books.
- Gander, S. (2002). Does Learning Occur through gaming. *Electronic Journal of Instructional Science and Technology*, 3(2).
- Gee, J. P. (2003). *What Video games have to teach us about learning and literacy*. New York: Palgrave-McMillan.
- Gee, J. P. (2004, 24. March). Learning by Design: Games as Learning Machines. *Gamasutra*.
- Gee, J. P., Lieberman, D., Raybourn, E., & Rajeski, D. (2004). *How Can Games Shape Future Behaviors*. Retrieved 21. October, 2004, from <http://www.watercoolergames.org/archives/000263.shtml#howcan>

- Healy, J. M. (1999). *FAILURE TO CONNECT: How Computers Affect Our Children's Minds*. New York: Touchstone.
- Jolicoeur, K., & Berger, D. E. (1998a). Implementing Educational Software and Evaluating Its Academic Effectiveness: Part I. *Educational Technology*, 28(10).
- Jolicoeur, K., & Berger, D. E. (1998b). Implementing Educational Software and Evaluating Its Academic Effectiveness: Part II. *Educational Technology*, 25(10).
- Jonassen, D. (2001). Learning from, in, and with Multimedia: An ecological Psychology Perspective. In S. Dijkstra, D. Jonassen & D. Sembill (Eds.), *Multimedia Learning: Results and Perspectives*. Frankfurt am Main: Peter Lang.
- Kafai, Y. B. (2001). *The Educational Potential of Electronic Games: From Games-To-Teach to Games-To-Learn*. Paper presented at the Playing by the Rules, Cultural Policy Center, University of Chicago.
- Klawe, M. M. (1998). *When Does The Use Of Computer Games And Other Interactive Multimedia Software Help Students Learn Mathematics?* Unpublished manuscript.
- Klawe, M. M., & Phillips, E. (1995). *A classroom study: Electronic games engage children as researchers*. Paper presented at the CSCL 1995, Bloomington, Indiana.
- Konzack, L. (2003). *Edutainment : leg og lær med computermediet*. Aalborg: Aalborg Universitetsforlag.
- Levin, J. (1981). Estimation techniques for arithmetic: Everyday math and mathematics instruction. *Educational Studies in Mathematics*, 12, 421-434.
- Leyland, B. (1996). *How can computer games offer deep learning and still be fun?* Paper presented at the Ascilite, Adelaide , Australia.
- Lieberman, D. A. (1997). Interactive Video Games for Health Promotion: Effects on Knowledge, Self-Efficacy, Social Support, and Health. In G. Street & Manning (Eds.), *Health Promotion and Interactive Technology: Theoretical Applications and Future Directions* (pp. 103-120). Mahwah, NJ: Lawrence Erlbaum Associates.
- Lieberman, D. A. (2001). Management of Chronic Pediatric Diseases with Interactive Health Games: Theory and Research Findings. *Journal of Ambulatory Care Management*, 24(1), 26-38.
- Malone, T. W. (1980). *What makes things fun to learn? Heuristics for designing instructional computer games*. Paper presented at the Symposium on Small Systems archive., Palo Alto, California, United States.
- Malone, T. W., & Lepper, M. (1987a). Intrinsic Motivation and Instructional Effectiveness in Computer-based Education. In Snow & Farr (Eds.), *Aptitude learning, and instruction*. London: Lawrence Erlbaum Associates Publishers.
- Malone, T. W., & Lepper, M. (1987b). Making learning fun: A Taxonomy of Intrinsic Motivation for Learning. In Snow & Farr (Eds.), *Aptitude learning, and instruction*. London: Lawrence Erlbaum Associates Publishers.
- McFarlane, A., Sparrowhawk, A., & Heald, Y. (2002). *Report on the educational use of games. Teachers Evaluating Educational Multimedia*. Cambridge.
- McMullen, D. (1987). *Drills vs. Games - Any Differences? A Pilot Study.*: ERIC.
- Okan, Z. (2003). Edutainment: is learning at risk? *British Journal of Educational Technology*, 34(3), 255-264.
- Pahl, R., H. (1991). Finally, a Good Way to Teach City Government! A Review of the Computer Simulation Game SimCity. *Social-Studies*, 82(4), 165-166.
- Prensky, M. (2001). *Digital Game-Based Learning*. New York: McGraw-Hill.
- Prensky, M. (2004). The Motivation of Gameplay. *On the Horizon*, 10(1).

- Randel, J. M., Morris, B. A., Wetzel, C. D., & Whitehill, B. V. (1992). The Effectiveness of Games for Educational Purposes: A Review of Recent Research. *Simulation & Gaming, 23*(3), 261-276.
- Rosas, R. e. a. (2003). Beyond Nintendo: A design and assessment of educational video games for first and second grade students. *Computers & Education, 40*, 71-94.
- Schank, R. C. (1999). *Dynamic Memory Revisited*. Cambridge: Cambridge University Press.
- Sedighian, K., & Sedighian, A. S. (1996). *Can Educational Computer Games Help Educators Learn About the Psychology of Learning Mathematics in Children?* Paper presented at the 18th Annual Meeting of the International Group for the Psychology of Mathematics Education, Florida.
- Squire, K. (2004). *Replaying history*. Unpublished Dissertation submitted in part fulfilment of the requirements of the Doctor of Philosophy (Instructional technology). Indiana University., Indiana.
- Squire, K., Barnett, M., Grant, J. M., & Higginbotham, T. (2004). *Electromagnetism Supercharged!* Paper presented at the International Conference of the Learning Sciences 2004, Los Angeles.
- Sutton-Smith, B., & Kelly-Byrne, D. (1984). The idealization of play. In P. K. Smith (Ed.), *Play in Animals and Humans*. Oxford: Basil Blackwell Inc.
- Thomas, R., Cahill, J., & Santilli, L. (1997). Using an interactive computer game to increase skill and self-efficacy regarding safer sex negotiation: field test results. *Health Education & Behavior: the Official Publication of the Society for Public Health Education, 24*(1), 71-86.
- Turnin, M. C., Couvaras, O., Jouret, B., Tauber, M. T., Bolzonella, C., Fabre, D., et al. (2000). Learning good eating habits playing computer games at school: A 2000 children evaluation. *Diabetes Research and Clinical Practice, 50*(1001), 239-239.
- Van Sickle, R. (1986). A Quantitative Review of Research on Instructional Simulation Gaming: A Twenty-Year Perspective. *Theory Research in Social Education, 14*(3), 245-264.
- Vandeventer, S. (1997). *Expert Behaviour among outstanding Videogame-playing Children*. Unpublished Dissertation submitted in part fulfilment of the requirements of the Doctor of Philosophy (Curriculum and Instruction). University of South Florida., Florida.
- Wenger, E. (1999). *Communities of Practice: Learning, Meaning, and Identity*. Cambridge: Cambridge University Press.
- Wertsch, J., V. (1991). *Voices of the mind: A sociocultural approach to mediated action*. Cambridge, MA: Harvard University Press.
- Wertsch, J., V. (1998). *Mind as action*. New York: Oxford University Press.
- Whitebread, D. (1997). Developing children's problem-solving: the educational uses of adventure games. In A. McFarlane (Ed.), *Information technology and Authentic Learning*. London: Routledge.
- Wiebe, J. H., & Martin, N. J. (1994). The impact of a computer-based adventure game on achievement and attitudes in geography. *Journal of Computing in Childhood Education, 5*(1), 61-71.