

# Chapter 1

## Research Review: Empirical Studies on Computer Game Play in Science Education

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### ABSTRACT

*The interest for game-based learning is growing among science educators. A range of research reviews have been published regarding the educational potentials of using computer games as a tool for learning and mediation, but on a general level. This research review focuses on empirical studies conducted on computer game play specifically used to enhance science learning. 50 publications published during the last decade were found that met the criteria of presenting empirical data from students using games for learning science in school contexts. The studies are reviewed and analysed according to: type of game, research design, research interests and research methodology, school subject and content, number and age of students, time spent on the intervention, gender, and teacher roles. The scope and quality of the studies are also discussed.*

### EDUCATIONAL POTENTIALS OF COMPUTER GAME PLAY

Researchers have long suggested that science instruction should provide students with opportunities to explore the world, and to make connections between these explorations and their personal lives (e.g. Aikenhead, 2007; Linder et al., 2007; Zeidler, 2007). Science educators in many countries have, accordingly, worked for decades to infuse inquiry

into the school, but good scientific inquiry seems to be hard to implement in classrooms (Ekborg et al., 2009; Linder et al., 2007). Evaluations report, that given the constraints of classroom settings, real world data collection and laboratory experiments are difficult to conduct, meaning that there are limited opportunities for teaching higher order inquiry skills in the ordinary classroom (Linder et al., 2007). The contextual clues offered to teachers by textbooks tend to lead away from inquiry (Phelps & Lee, 2003). Game-based learning approaches, on the other hand, are constructed to

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situate learners in complex and authentic tasks. Given the widely acknowledged lack of student interest in school science, and the downward trend in results (e.g. Jidesjö & Oscarsson, 2006; Linder et al., 2007; Osborne, 2007), the educational potential of computer game play (e.g. Aitkin, 2004; Gee, 2003; Klopfer, 2008; Williamson, 2009) might be of interest to science educators. To achieve this, authentic problems, concepts and processes are embedded in the narrative, that provide scope for scientific inquiry (Barab et al., 2007; 2007a, 2007b; Ketelhut, 2007; Magnussen, 2008; Neulight et al. 2007).

When comparing scientific literacy or science education standards (e.g. NRC, 1996; OECD, 2003) with the characteristics of computer games, some striking correspondences can be found. Squire and Jan (2007), for example, identify five core features pertinent to designing computer games for learning. (1) Games ask students to *inhabit roles*. Players are encouraged to create identities that blend the game player role and the role as a scientific professional. All information, experiences and rewards occur within this role, leading to the development of specific skills and competencies mediated by digital tools (e.g. digital lab equipment). (2) The activities in the game are organised around *challenges* and rewards, designed to support engagement, collaboration, and learning. (3) The games offer opportunities to tie goals to particular places, particularly sites of *contested spaces*. (4) The games allow for embedding *authentic resources* and tools that enable acting on higher levels. Digital tools, such as research labs and calculators, both mediate play and provide opportunities for players to interact with the environment in new ways. (5) Playing games is fundamentally social, and produces *social interaction*. After having been met with scepticism at the outset, and seen as “only play”, public interest in computer games as learning tools seems to be spreading internationally (Van Eck, 2006, p. 2). On the other hand, even if theoretical assumptions ascribe computer games great poten-

tial for learning, strict empirical research is still lacking, to explain if and why computer games are effective in practice, and if so, under which conditions (e.g. Egenfeldt-Nielsen, 2007; Hanghøj, 2008; Linderoth, 2009; Williamson, 2009; Wong et al., 2007). Aitkin (2004) compares the nature of today’s science research with simulation games, and points to simulation as the core of most scientific research today.

To meet the need for more empirical observation on the possibilities gaming can provide, a number of educational computer games have been developed, in various university projects. In these games, researchers have attempted to combine socio-cultural or constructivist approaches to learning, with the affordances of contemporary computer games, with the aim to engage students in authentic, deep forms of inquiry (e.g. Barab et al., 2007a, 2007b; Beckett & Shaffer, 2005; Squire & Jan, 2007). The focus is on offering affordances of making observations, posing questions, gathering data, experimenting, examining books, and so on, as tools for scientific inquiry processes (Ketelhut, 2007). Using educational games, students are invited to explore and negotiate *contested spaces*. Besides the computer games which have specifically been developed for educational purposes in these projects, the possibility of using commercial off-the-shelf (COTS) games for science learning has also been investigated in a few studies (Nilsson & Jakobsson, Accepted; Nilsson & Svingby, Accepted; Steinkuhler & Chmiel, 2006). The aim of the present review is to review computer game projects intended to enhance the teaching and learning of science, also including COTS games.

## EARLIER REVIEWS OF COMPUTER GAME PLAY IN RELATION TO LEARNING

Even the first review studies of computer game play and learning (e.g. Van Sickle, 1986; Randel et al., 1992) showed that computer games could

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