

Chapter 43

Developing Video Games for Physics Education

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ABSTRACT

This chapter reviews the potential of videogames to enhance physics education, and provide guidelines for designing educational videogames that promote physics learning objectives by integrating them into gameplay mechanics. It also presents the available technology solutions for educational videogame development. To put the design of physics educational games into context, the chapter reviews the existing research into videogames for physics education and the main learning theories in light of how they associate to the various videogame genres. Finally, the barriers that currently inhibit widespread adoption of videogames in educational environments are discussed and future directions of research into the field are indicated.

INTRODUCTION

Students' interest in science topics is gradually declining in most countries. Physics is one of the subjects that is considerably suffering (Sandford et al, 2006; Smithers & Robinson, 2005; Kessels et al, 2007). Naturally, this has an impact on the number of people studying Physics-related

subjects and doing research in Physics, which is gradually reducing. According to the International Perceptions of UK Research in Physics and Astronomy Report (IOP, 2000): "Physics (including astronomy) is an integral part of our culture, providing the foundations for many scientific disciplines including chemistry, biology, the geo-sciences and engineering. The increase in wealth, economic globalization, living standards

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and the quality of life in the 20th century have been largely based on technological progress which in turn has relied heavily on innovative research in physics. These trends are anticipated to continue and, indeed, strengthen in the 21st Century”.

The declining interest can partly be attributed to the pedagogical approach used to teach Physics in educational environments, which is mostly based on simple transfer of facts and mathematical formulas that represent the laws of Physics (Sandford et al, 2006). Students have fewer opportunities to augment traditional narrative teaching with hands on experience in laboratories. As a result scientific reasoning skills remain underdeveloped.

There is an extensive body of research work that advocates videogames’ great potential to enhance the learning process (Chen et al, 2005; Gee, 2007; Prensky, 2007; Klopfer et al, 2009). Videogames offer a complex, interactive and visual environment with clear goals, rules and feedback that can stimulate and engage students. In games students formulate theories on how to approach a problem, work to overcome it and, in case of failure, adjust the theory and try again. Physics is just one of the subjects that can potentially benefit from such learning environments. However, developing educational videogames that enhance Physics learning is not a straightforward process. Specialized game design is needed in order to successfully integrate learning goals and gameplay and allow students to reflect upon the physics concepts.

In this chapter we explore the educational potential of videogames for Physics education and investigate how well videogames map to existing learning theories. We also build a theoretical framework of videogame design that integrates learning and gameplay in order to enhance Physics education. Finally, we highlight the particularities of videogame design for Physics education. The barriers that hinder production of physics education videogames as well as their wider adoption as teaching resource is also discussed.

TRADITIONAL TEACHING APPROACHES IN PHYSICS EDUCATION

Science is considered by the majority of school children as a difficult subject. According to a report by UK’s NESTA (Sandford et al, 2006) pupils in the UK are losing interest in science because too often the subject is being taught as just facts and formulas on a blackboard. Similar results in the USA were documented in Smithers and Robinson (2005) report. It appears that the prevalent approach in delivering physics knowledge across all levels of education (primary, secondary and university level) is by instruction in a lecture based format. Occasionally, this approach is supplemented by the addition of laboratory work and ICT elements. However the main idea firmly remains learning through instruction and textbook.

In addition, instruction aims to present physics concepts mainly through mathematical formulae and definitions, with the conceptual element of physics teaching to be suppressed. Students practice their understanding and test their knowledge primarily through solving end-of-chapter problems. However research suggests that even after successfully solving physics problems, students lack in conceptual understanding. (Kim & Pak, 2002; Twigger et al, 1994).

It is becoming evident that mastery of the quantitative component of physics does not necessarily lead or implies a grounding understanding of physics concepts. However, although it appears that the quantitative approach to physics teaching is prevailing, it is the conceptual understanding that lay the foundations for a concrete understanding of physics. Research suggests that students should deeply understand qualitatively the physics principles, before embarking in quantitative problems (Forbes, 1997; White et al, 1998).

It should be noted, that while physics education in schools and universities is largely dominated by traditional teaching methods, there are efforts all over the world either to enhance traditional teach-

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