Chapter 1
Using Technology to Enhance Science Literacy, Mathematics Literacy, or Technology Literacy:
Focusing on Integrated STEM Concepts in a Digital Game

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ABSTRACT

This chapter explores the potential of a digital game, The History of Biology (HoB) as a learning environment in which today's learners find technology engaging and practical to advance their learning and interact with STEM content. The authors report on a study which assumed an explicit-reflective teaching approach from the perspective that the HoB game was developed in the context of the history, philosophy, and sociology of science and technology. The study addressed the following question: What effect, if any, does HoB have on students' a) learning 21st century skills, and b) engagement with integrated STEM content? The authors hypothesize that by providing opportunities for exploring integrated STEM content via a digital online game, pre-service science students may enhance their own numeracy, and scientific and technological literacy, and also develop positive attitudes toward teaching STEM content through digital technologies in the classroom.

INTRODUCTION

There is a worldwide call for schools to improve students' numeracy, scientific and technological literacy, as well as their understanding of science and technology content, socio-scientific issues, the nature of

DOI: 10.4018/978-1-4666-9616-7.ch001

science, and scientific and technological problem-solving (Millar, 2006). The shift in our society's growing reliance on technology demands that our students' education emphasize technological literacy, thus benefitting students who may or may not pursue technology based careers, such as engineering and architecture. Furthermore, there is a need for students to experience opportunities in formal and informal settings that will result in enhancing 21st century learning skills such as (a) creativity and innovation; (b) critical thinking and problem solving; (c) communication; (d) collaboration; (e) information literacy; (f) media literacy; (g) information and communications technology (ICT) literacy; (h) flexibility and adaptability; (i) initiative and self-direction; (j) social and cross-cultural skills; (k) productivity and accountability; and (l) leadership and responsibility, as detailed in NSTA's 21st Century Skills Map (NRC, 2011; Partnership for 21st Century Skills, 2009). The all-encompassing nature of this list targets the growth and development of global citizens who are effective at problem-solving and decision-making (Silva, 2009). While educators and others have listed and described 21st century skills, teachers continue to search for strategies to effectively address the development of these skills in the preferred learning styles of today's students.

The serious games movement (Annetta et al., 2006; Lester et al., 2014; Spires, 2008) is responding to the need to unite content and game play as a way to promote 21st century skills. One avenue for enhancing literacy – scientific, engineering, technological, and numeracy – and developing 21st century skills is through the implementation of digital games with integrated science, technology, engineering, and mathematics (STEM) education. Learning environments can be transformed to be more effective and powerful using serious games (Wrzesien & Raya, 2010). However, despite today's students' emerging learning styles and the educational value of computer-based games, few educators use digital games in any substantive way in teaching and learning. The authors report on the exploration of *History of Biology* (*HoB*) as a learning environment in which today's learners find technology engaging and practical to advance their learning and interaction with STEM content. *HoB* is an innovative educational game that uses a combination of strategies such as story, interactive puzzles, mini-games, and online scavenger hunts. Thus, the *objectives* of this study are to explore if and how *HoB* impacts students' a) 21st century learning skills, and b) engagement with integrated STEM content.

BACKGROUND

Digital Games and Pedagogical Orientations

Studies of student's learning styles have shown that recent advances in ICT are reshaping the ways in which students of the "Net Generation" (Annetta, 2008; Trotter, 2005) learn and prefer to learn. For example, Dede (2005) reported that today's students' emerging learning styles include: fluency in multiple media and simulation-based virtual settings; communal learning; experiential learning; guided mentoring and collective reflection; and co-designing learning experiences that are personalized to individual needs and preferences. To better support today's students, it is necessary for teachers to reflect upon their own practices and adapt similar teaching styles (Foster & Mishra, 2009).

A primary challenge for education is to transform student's learning processes in and out of school and to engage student interest in gaining 21st century skills and knowledge. Lemke (2004) reported a link between 21st century skills and academic achievement, making the case for incorporating teaching activities that adhere to 21st century skills. Furthermore, the report by the Federation of American