

Chapter 9

Integrating Game–Enhanced Mathematics Learning into the Pre–Service Training of Teachers

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ABSTRACT

Mathematical literacy is a core literacy that functions as a critical gatekeeper for participation in many aspects of modern society. Research has shown that the way mathematics is taught at school is highly associated with students' achievement and interest levels. Declining interest in mathematics and the need to raise the educational standards of youth in this discipline set a critical agenda for the revision of pedagogical practices. Digital games hold a lot of promise as tools for improving mathematics instruction at the school level. This chapter reports the main insights gained from a study that implemented a game-enhanced learning environment for the training of pre-service elementary school teachers. Teachers experienced some of the ways in which online educational games could help students internalize key mathematical concepts across the school curriculum and build their problem-solving skills, while at the same time improving their attitudes towards the subject. The course also familiarized teachers with the design principles for constructivist gaming environments. Findings indicate a positive impact on teachers' competence in selecting, evaluating, and productively using online games as an instructional tool.

INTRODUCTION

In technology-based society, mathematics provides essential knowledge tools and the foundations for more advanced or specialized training either in higher education or through lifelong

learning. Low proficiency in mathematics is highly correlated with low academic attainment, which leads to lower participation in the labour market and in lifelong learning activities after compulsory schooling (Commission of the European Communities, 2007). Despite, however, the fact that the development of mathematical knowledge and literacy is a fundamental requirement in

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modern society, cross-national studies of student achievement (e.g. Trends in International Mathematics and Science Study [TIMSS], Programme for International Student Assessment [PISA]) indicate lack of mathematical competence for a considerable proportion of the student population around Europe and internationally. There is also well-documented evidence of declining interest in key science and mathematics topics, as well as in science careers (e.g. European Commission, 2007; U.S. Department of Education, 2000; Osborne & Collins, 2001; Adleman, 2004; Jenkins & Nelson 2005; Sjøberg & Schreiner, 2006; OECD, 2006). Students' low achievement and declining interest in mathematics is of concern given that mathematical literacy serves as one of the foundational areas of knowledge that drives scientific and technological advancement in knowledge-based economies (European Commission, 2004). Research suggests that students' mathematics identity is formed in the elementary grades and predicts their mathematics achievement in later years (Tate & Rousseau, 2002; Tate, 2005), and that pupils with poor quantitative skills are likely to have fallen behind by the age of ten (DfES, 2003). Thus, learning substantial mathematics is critical for young children, since the early years of schooling are especially important for children's mathematical development (Sarama & Clements, 2009).

Technology advances have provided the opportunity to create an entirely new learning environment in mathematics by significantly increasing the range and sophistication of possible classroom activities. Access to technology provides teachers and children with tools which, when constructively used, can create opportunities for enhanced learning of mathematics. Although traditional, teacher-centered approaches to mathematics instruction still dominate, there have been several attempts to improve mathematics instruction through the integration of learning technologies. One promising approach explored is the potential of computer games as tools for

supporting mathematics teaching and learning. The literature indicates strongly the educational value of using games within mathematics education (e.g. Resnick et al, 1996; Jonker & van Galen, 2004; Simpson et al., 2006).

The current article contributes to the emerging literature on game-enhanced mathematics teaching and learning. It reports on the main experiences gained from a study that aimed at providing a group of pre-service primary school teachers with the knowledge, skills, and confidence required to incorporate game-enhanced learning within the mathematics curriculum.

BACKGROUND

The formalist tradition has, in recent years, come under attack. A new paradigm has emerged, which views mathematics and science as meaning-making activities of a society of practitioners (Lakatos, 1976; Latour, 1987). Educational leaders and professional organizations in mathematics education (e.g. National Council of Teachers of Mathematics, 2000, Commission of the European Communities, 2007) have been advocating the adoption of more active learning environments that motivate learners, and encourage them through authentic inquiry to establish the relevance and meaning of mathematical concepts. These leaders stress the fact that the core of school mathematics should no longer be the teaching of techniques and calculations that computers can do much faster and more reliably, but the development of problem-solving skills that students will need to effectively live and function in a highly complex society. This shift is being reflected in most countries' educational policies and official curricula, which advocate pedagogical approaches that support inquiry-based, problem-solving learning of mathematics.

Despite the extensive calls for the uptake of learner-centered, inquiry-based pedagogical models, changing teaching practices is proving to be

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