Chapter 16
Gamification of Middle School Mathematics and Science:
Game–Playing for Learning

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ABSTRACT

Gamification, defined as the process of game-thinking and game mechanics to engage users and solve problems, is a fairly new and rapidly growing field. Literature suggests that gamification can contribute to develop higher order cognitive abilities such as problem solving and critical thinking skills. Using gamification in non-game situations enhances students' understanding and contributes on conceptual learning, especially in mathematics and science. This chapter introduces the concept of gamification in terms of its pedagogical underpinnings, integration of gamification into educational environments (with a focus on mathematics and science), a sample application of gamification in science content, and the future trends about possible directions of uses of gamification.

INTRODUCTION

Contemporarily, all of us live in a world surrounded by rapidly changing technologies. The computers play important role in education since 1980s. Computer assisted learning can be simply defined as the learning procedures and environments facilitated through computers. In education environments, students learn with or from technology. In the concept of learning from technology, teachers adopt required

technological tools in order to create learning environments in the similar ways that they always teach. In this process, the information to be taught is first embedded in technology then technological materials become new way to teach information to students. In contrast to "from", in the process of learning with technologies, students engage themselves for learning in technology. For integrating successfully technology into educational settings, theories of learning have to be efficiently adapted and related curricula should be developed in terms of technologically content. As constructive approach recommends, students need teachers' guidance in order to construct their knowledge.

Instructional and educational technology are two terms that share almost same definitions. Earle (2002) defines these terms as "both share a common interest in the processes of human learning and teaching, with some variations in definitions and levels of complexity, depending upon one's personal viewpoint". Considered as a basic element for increasing academic achievement of students, educational technology refers in general computers and computer programs' introduction to the educational environments (Wenglinsky, 2005).

Contemporarily, studies about educational technology take important attention. According to these studies (Slavin & Lake, 2008; Slavin, et al., 2009; Li, & Ma, 2010), educational technologies have positive effect on students' academic achievement. Literature provides several explanations for the limited use of technology in schools. This limitation includes mismatch between technology and curriculum objectives, lack of time to integrate technology into tightly planned classroom sessions, teachers' ability to use technology, and lack of resources and lack of support systems (Baylor, & Ritchie, 2002; Hawkins, Spielvogel, & Panush, 1996; Windschitl, & Sahl, 2002; Zbiek, & Hollebrands, 2008). Meanwhile students of this age encounter new types of information sources such as YouTube. In addition, under the consideration the fact that their willing to play computer or online games are increasing in time, the games can be thought a new way of learning environment. Therefore, "gamification" term is one of the new trends in education. This chapter provides a detailed framework for using gamification (including theoretical background) in educational settings and presents a sample application of gamification to the teaching of middle school mathematics and science.

GAME-BASED LEARNING

The popularity of computer games among people has been increasing rapidly across all age groups. People who play computer games find that these games can be engaging and intriguing (Garris, Ahler, & Driskell., 2002). During game-play, some of the tasks that are presented require the players to demonstrate tenacity toward finding the solutions for the task. While problem solving skills and persistence are fundamental skills to be developed by an individual for the modern workplace, but students are not likely to have an opportunity granted to acquire these skills from the current school systems (Shute & Ke, 2012). Prior empirical evidence showed that games could be an effective learning tool to enhance learning and assist learners in comprehending a complex level of studies (Cordova & Lepper, 1996).

This phenomenon has captured educational professionals' attention. Considerable scholars have shown interest in using games to enhance learning (Prensky, 2006; Shaffer, Squire, Halverson, & Gee, 2005; Shute, Riber, & Van Eck, 2011). GBL has permeated education (Danielsson & Wiberg, 2006) due to the increased potential of the educational benefits of games and their capability to create a better learning environment to support interactive, engaging, and immersive activities (Gunter, Kenny, & Vick, 2008). Garris et al. (2002) referred to gaming as an activity where students play a game and return to

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