Chapter 21
Emotional Agents in Educational Game Design: Heroes of Math Island

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ABSTRACT

Evaluating the subjective playing experience and engagement in learning is important in the design of advanced learning technologies (ALTs) that respond to the learners' cognitive and emotional states. This article addresses students' attitudes toward an educational game, Heroes of Math Island, and their responses to the emotional agent, an animated monkey. Fifteen students (seven boys and eight girls) from grades six and seven participated in this quasi-experimental study (pretest, intervention, post-test, followed by post-questionnaire and interview). This research presents a detailed analysis of students' subjective reactions with respect to Heroes of Math Island and to the underlying mathematics content, their learning gains and emotions triggered during gameplay, and design issues resulting from the evaluation of the game and of its emotional agent. The findings from this study inform how ALTs and educational games can be designed in order to be effective and provide emotional engagement, enjoyment, and learning.

1. OBJECTIVES

Educational games have a range of cognitive, emotional, motivational, and social benefits (Carvalho et al., 2015; Crookall, 2010; Ge & Ifenthaler, 2018). Video games designed to enhance or simulate educational experience are, in other words, advanced learning technologies (ATLs) (Conati, Jaques, & Muir, 2013; Rodrigo, et al., 2012). According to Aleven, Beal, and Graesser (2013), ALTs "provide a high degree of interactivity, reflecting a view of learning as a complex, constructive activity on the part of

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learners that can be enhanced with detailed, adaptive guidance" and are capable of assessing or tracking learners' experiences, including learning strategies and affective states (pp. 929-930).

In "Why Games Don't Teach," Clark (2013) argued that "advocating games as a main or even frequent instructional strategy is misleading" and encouraged the development of a "taxonomy of games or game features that link to desired instructional outcomes" (p. 10). She noted the "insufficient well-designed experimental research on which to base many conclusions" (Clark, 2013, p. 1). Downsides are reported in literature, such as the appeal of video games as entertainment (Persico, et al., 2018) and the lack of correlation between playing video games as leisure activities and school cognitive tests, i.e., comprehension, math, school knowledge, and reasoning tests (Lieury, Lorant, Trosseille, Champault, & Vourc'h, 2016). Although Clark's argument for better alignment of game design with learning outcomes is valid and downsides should be considered, the educational literature presents evidence of the effectiveness of game-based learning (GBL) (de Freitas, 2013; Ge & Ifenthaler, 2018; Kiili, Ketamo, Koivisto, & Finn, 2014; Hosseini & Mostafapour, 2020; Partovi & Razavi, 2019; Spires, Rowe, Mott, & Lester, 2011). In a study that explored primary school children's technology acceptance, Camilleri and Camilleri (2019) reported that students recognized the usefulness and relevance of educational games played at school. However, important shortcomings result from design focused on content, as designers of educational games often "develop products that miss the most essential mechanism of engagement in games— the fun" (Granic, Lobel, & Engels, 2014, p. 74).

This article is derived from a larger study that involved the design and implementation of an educational game titled *Heroes of Math Island* (Gutica, 2014). Using design-based research (DBR), the larger study explored students' emotions during gameplay, learning gains, as well as their subjective attitudes towards the game and learning. We address in this article the following research questions:

- What are the students' subjective reactions to *Heroes of Math Island*?
- What are their emotional responses to the game and emotional agent?
- What are their levels of interest and achievement in the mathematics content after gameplay?

2. THEORETICAL FRAMEWORK

In this article, "affect," "affective state," and "emotion" are used interchangeably. Many contemporary scientists and theorists define emotion in a context of cognition and motivation (LeDoux, 1995; Ortony & Turner, 1990; Plutchik, 1984; Rolls, 1995). According to LeDoux (1996), "once emotions occur they become powerful motivators of future behaviors. They chart the course of moment-to-moment action as well as set the sails toward long-term achievements" (p. 20). The relationships between emotion and learning are varied and complex (Petrina, 2007, pp. 53-90). Astleitner (2000) empirically validated his theoretical instructional design approach employing five emotions— fear, envy, anger, sympathy, pleasure (FEASP)— and demonstrated the existence of a significant correlation between sympathy-related and pleasure-related instructional strategies and corresponding emotions in learners. Hascher (2010) stated that a positive environment is an "optimal precondition for holistic and creative thinking as it does not force the learner to cope with the situation but enables open-mindedness" (p. 15). However, this is a simplistic approach and the "valence of a mood or an emotion (being positive or negative) is only one aspect of its quality" (Hascher, 2010, p. 16). Educational research is well served by empirical and