Design and Development of a Simulation for Testing the Effects of Instructional Gaming Characteristics on Learning of Basic Statistical Skills

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ABSTRACT

Considerable resources have been invested in examining the game design principles that best foster learning. One way to understand what constitutes a well-designed instructional game is to examine the relationship between gaming characteristics and actual learning. This report discusses the lessons learned from the design and development process of instructional simulations that are enhanced by competition and storyline gaming characteristics and developed as instructional interventions for a study on the effects of gaming characteristics on learning effectiveness and engagement. The goal of the instructional simulations was to engage college students in learning the statistics concepts of standard deviation and the empirical rule. A pilot study followed by a small-scale experimental study were conducted to improve the value and effectiveness of these designed simulations. Based on these findings, specific practical implications are offered for designing actual learning environments that are enhanced by competition and storyline gaming elements.

Keywords: Competition, Game Design Characteristics, Instructional Games, Simulations, Storyline

INTRODUCTION

The present report describes the lessons learned from designing and developing instructional simulations, enhanced with competition and storyline gaming characteristics (GCs) to teach college students basic statistics concepts of standard deviation and the empirical rule. We developed these simulations as instructional interventions for an empirical study that would explore the potential benefits of embedding these two GCs in an instructional content.

Table 1. Summary of gaming characteristics

	Characteristic	Description
15.	Challenge	The activity is not too hard and not too easy.
16.	Competition	Players stretch their skills to meet opponents' skill level and to generate players' desire to continuously perfect their skills. The competition can be implemented between individual players, amongst teams, and even between players and the system.
17.	Rules	Impose limits and guidelines on actions; represent the evaluation criteria in the form of scoring and promoting players during the process.
18.	Goals	The final result or achievement that player's actions or decisions should be directed to.
19.	Fantasy	Unreal game situation or environment.
20.	Changed Reality	Altering time, space, role playing, and the complexity of situations to exaggerate experiences in a specific context.
21.	Immediate Feedback	Informs game players where they are in the game as well as how they perform on certain tasks.
22.	Interaction	Structural components which allow players to interface with other players, game context, and the system
23.	Storyline	A "glue" for connecting scenes in the games with the educational content (Rieber, Davis, Matzko, & Grant, 2001).
24.	Engagement/ Curiosity	Engagement created by games allows players to become deeply involved in the game that players lose the sense of realistic self. In other words, players perceive themselves as part of the game and enjoy the intrinsically motivating game play experiences.
25.	Control	Manipulating the virtual environment through keyboard/mouse/voice/etc. interfaces
26.	Role Playing	Assuming the role of a character embedded in the story of the game
27.	Task	A building block of a game's goal; players take on sequences of tasks in order to achieve the game's final goals
28.	Multimodal Presentation	Different types of presentations that enrich game experience (art, animation, text, audio)

Note. Adapted from "Instructional gaming effects on learning outcomes and instructional strategy selection" by Johnson et al., 2007.

Gaming characteristics are essential core design elements of game-enhanced learning environments. Among the most cited are rules/goals, challenge, control over the learning environment, sensory stimuli, competition, fantasy/storyline, and interactivity (Garris, Ahlers, & Driskell, 2002). Researchers argue that using learning theories related to GCs are one of the key principles for designing games that promote effective learning (Gee, 2003; Shute, Rieber, & Van Eck, 2010; Shute et al., 2009). GCs directly link to general learning outcomes, e.g., improved interest in a subject area, and are critical to integration games effectively into instruction. They are factors that can refine theoretical formulations for effective instruction. Using gaming literature analysis, several researchers identified a number of GCs that have the potential to affect various aspects of game-based learning (Johnson, Spector, Huang, & Novak, 2007; Wilson et al., 2009). We present definitions of 14 GCs pinpointed by Johnson and colleagues to identify them here (see Table 1).

Lepper (1985) addressed the importance of examining GCs more than twenty years ago (Lepper, 1985), but since then very few empirical studies have established links between GCs and human performance. Recently, Wilson et al. (2009) again stressed the importance of examining the effects of specific GCs on learning, arguing that since most games include

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