Chapter 4

Investigating Epistemic Stances in Game Play Through Learning Analytics

Mario Martinez-Garza
Independent Researcher, USA

Douglas B. Clark
University of Calgary, Canada

ABSTRACT

The authors apply techniques of statistical computing to data logs to investigate the patterns in students’ play of The Fuzzy Chronicles and how these patterns relate to learning outcomes related to Newtonian kinematics. This chapter has two goals. The first goal is to investigate the basic claims of the proposed two-system framework for game-based learning (or 2SM) that may serve as part of a general-use explanatory framework for educational gaming. The second goal is to explore and demonstrate the use of automated log files of student play as evidence of learning through educational data mining techniques. These goals were pursued via two research questions. The first research question examines whether students playing the game showed evidence of dichotomous fast/slow modes of solution. A second research question investigates the connection between conceptual understanding and student performance in conceptually-laden challenges. Implications in terms of game design, learning analytics, and refinement of the 2SM are discussed.
INTRODUCTION

Digital games are potentially powerful vehicles for learning (de Freitas; 2018; Gee, 2007; Prensky, 2006; Mayo, 2009; Shaffer, Squire, Halverson, & Gee, 2005; Rieber, 1996; Squire et al., 2003), and numerous empirical studies have linked classroom use of educational games to increased learning outcomes in science (e.g., Annetta, Minogue, Holmes, & Cheng, 2009; Dieterle, 2009; Neulight, Kafai, Kao, Foley, & Galas, 2007; Squire, Barnett, Grant, & Higginbotham, 2004). Several reviews have concluded that game-based learning offers numerous theoretical and practical affordances that can help foster students’ conceptual understanding, engagement, and self-efficacy (Aldrich, 2003; Cassell & Jenkins, 1998; Kafai, Heeter, Denner, & Sun, 2008; Kirriemuir & Mcfarlane, 2004; Martinez-Garza, Clark, & Nelson, 2012, Munz, Schumm, Wiesebruck, & Allgower, 2007). That said, not all games effectively support learning for all learners (Young et al., 2012). Clark, Tanner-Smith, and Killingsworth (2015) found favorable support for the use of educational games overall, but particularly in cases where games were augmented through the application of sound learning theory.

While the general question of whether games can provide productive contexts for learning is approaching consensus, how and why and when games work are more open questions. The effectiveness of game-based learning has been attributed to many causes (Linehan, Kirman, Lawson, & Chan, 2011; Dondlinger, 2007), including constructs as varied as fun, feedback, engagement, flow, problem-solving, narrative, etc. Several scholars have proposed design principles to optimally leverage some or all of these constructs (e.g., Annetta, 2010; Kelle, Klempe, & Specht, 2011; Tobias & Fletcher, 2007; Plass, Homer, & Kinzer, 2014). Also, educational games claim a broad spectrum of possible learning outcomes (Martinez-Garza, Clark, & Nelson, 2013b). Educational researchers have a vast space of explanations, design principles, and observed outcomes for game-based learning available, which in combination with the broad range of gaming genres, gaming populations, and technology platforms, creates a wide and constantly changing space of inquiry that resists generalized claims. Furthermore, digital games also present unique assessment challenges. Since games often incorporate novel student activities for which there are no well-established existing measurement methods, measures often need to be developed along with the game in an iterative fashion (Harpstead, Myers, & Aleven, 2013). Thus, some scholars have called for increased methodological rigor and emphasis on usable (i.e., generalizable) knowledge in educational games research (Dede, 2011; Foster & Mishra, 2008).
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