

Investigating Real-time Predictors of Engagement: Implications for Adaptive Videogames and Online Training

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ABSTRACT

Engagement is a worthwhile psychological construct to examine in the context of video games and online training. In this context, previous research suggests that the more engaged a person is, the more likely they are to experience overall positive affect while performing at a high level. This research builds on theories of engagement, Flow Theory, and Cognitive Load Theory, to operationalize engagement in terms of cognitive load, affect, and performance. An adaptive algorithm was then developed to test the proposed operationalization of engagement. Using a puzzle-based video game, player performance and engagement was compared across three conditions: adaptive gameplay, a traditional linear gameplay, and choice-based gameplay. Results show that those in the adaptive gameplay condition performed higher compared to those in the other two conditions without any degradation of overall affect or self-report of engagement.

Keywords: Adaptive, Affect, Cognitive Load, Engagement, Flow, Games, Performance, Training

INTRODUCTION

The purpose of this research is to explore, define, and test the efficacy of the psychological construct of engagement as a predictor of performance and affect in videogames and online training (Fredricks, Blumenfeld, & Paris, 2004). However its use as a means of defining user experience in online environments has often been confounded with related concepts such as self-efficacy, motivation, flow and presence

(c.f., Faiola, Newlon, Pfaff, & Smyslova, 2012). Similarly, it has also been recognized that how engagement is experienced by the user, measured, and interpreted may also vary between different computer-based tasks (Attfield, Kazai, Lalmas, & Piwowarski, 2011). For example, engagement has been examined in areas ranging from online-shopping (O'Brien & Toms, 2008), to online-learning (Chen, Lambert, & Guidry, 2010), to employee engagement (Macey & Schneider, 2008). Despite these

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variations, researchers agree that engagement is a positive contributor to online experiences and a worthwhile psychological construct to examine (e.g., Brockmyer et al., 2009; Whitton, 2011). Rather than attempt to create a single, overarching definition of engagement the research reported here narrows the scope of engagement to its theoretical importance and application in the synergistic area of videogames and game-based training—an area where high engagement is thought to be of the utmost importance (McGinnis, Bustard, Black, & Charles, 2008; Richardson & Newby, 2006; Whitton, 2011).

Theoretical Underpinnings

Engagement, as it relates to game-based learning, has been associated with Flow Theory (FT) (Csikszentmihalyi, 1988). FT's (Csikszentmihalyi, 1988) principles have high face-validity and have proven to be one of more thorough and practical frameworks from which to begin the study of videogame behavior and engagement (O'Brien & Toms, 2008; Pavlas, Heyne, Bedwell, Lazzara, & Salas, 2010). O'Brien & Toms (2008) suggest that engagement may share some attributes with flow, such as focused attention, feedback, control, activity orientation (i.e., interactivity), and intrinsic motivation. FT helps capture the key concept of achievable challenge as a desirable, engaging element of computer-based tasks (Chanel, Rebetez, Bétrancourt, & Pun, 2008; Skelly, Fries, Linnett, Nass, & Reeves, 1994). FT is equally useful at linking cognitive effort with affective outcomes. Being in the flow can be thought of as an optimal experience that includes feelings of exhilaration and deep enjoyment (Csikszentmihalyi, 1990). The resulting positive affect provides a positive feedback loop for maximal cognitive effort. People in the flow are intrinsically motivated and commonly report focused concentration and feelings of control (Csikszentmihalyi, 1988).

Cognitive Load Theory

Challenge, recognized as a positive outcome within a game-based environment, can be

thought of as the level of cognitive load a person experiences during a task. Cognitive Load Theory (CLT) provides a framework for understanding the psychological relationship of challenge and skill. Similar to the predictions of FT, CLT also hypothesizes that an optimal cognitive state for learning will exist when a person's ability (skill) and the complexity (challenge) of their training task are appropriately balanced (Moreno & Park, 2010). CLT has been used to guide the design and selection of multimedia and instructional elements that will be more likely to maintain an optimal amount of cognitive load during training (Kalyuga, Chandler, & Sweller, 2004).

CLT's concept of intrinsic load represents the cognitive load generated from the gap between a person's current skill and the task challenges. Intrinsic load is likely to be highest when the ratio of challenge to skill is greatest and lowest where the ratio is reversed. Based on FT (Csikszentmihalyi, 1990), it is hypothesized that there would be an optimal balance of challenge to skill in a training situation that would represent a middle range of intrinsic load. By extension, it is believed that as novices gain experience in a new game, the challenge level will need to be raised to keep individuals in this optimal range. That is, for a player who is continuing to learn in the training environment, intrinsic load is a dynamic factor that changes both with knowledge acquisition and changing task challenge. Outside this middle range of challenge, performance gains would not be optimized because either cognitive capacity has been overloaded (causing frustration) or underutilized (causing boredom, or a state of perceived effortlessness).

CLT's concept of germane load (Paas & van Merriënboer, 1994) can be thought of as the amount of cognitive effort a person voluntarily expends on a task. Another way of considering germane load is to think of it as a form of intrinsic motivation (Mayer & Moreno, 2010), and that being motivated toward task completion requires a higher degree of cognitive processing. Intrinsic load needs to be high enough to provide meaningful challenge however, if intrinsic

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