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Challenging games help students learn: An empirical study on engagement, flow and immersion in game-based learning

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ABSTRACT

In this paper, we investigate the impact of flow (operationalized as heightened challenge and skill), engagement, and immersion on learning in game-based learning environments. The data was gathered through a survey from players ($N = 173$) of two learning games (*Quantum Spectre*: $N = 134$ and *Spumone*: $N = 40$). The results show that engagement in the game has a clear positive effect on learning, however, we did not find a significant effect between immersion in the game and learning. Challenge of the game had a positive effect on learning both directly and via the increased engagement. Being skilled in the game did not affect learning directly but by increasing engagement in the game. Both the challenge of the game and being skilled in the game had a positive effect on both being engaged and immersed in the game. The challenge in the game was an especially strong predictor of learning outcomes. For the design of educational games, the results suggest that the challenge of the game should be able to keep up with the learners growing abilities and learning in order to endorse continued learning in game-based learning environments.

1. Introduction

Pervasive student disengagement is both a national and an international problem, with 20–25% of students in 28 OECD (Organisation for Economic Co-operation and Development) countries classified as having low participation and/or a low sense of belonging (Drigas, Ioannidou, Kokkalia, & Lytras, 2014; Willms, 2003). A promising strategy for increasing engagement in a meaningful way has been thought to stem from video games (Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012; Gee, 2007; Steinkuehler, Squire, & Barab, 2012) and gamification (Hamari, Koivisto, & Sarsa, 2014) as observed by educational scholars for several decades.

In an ideal educational game setting, students learn how to solve complex problems. The problems within a game typically start off easy and then progressively become more difficult as players' skills develop. Players are motivated to learn, in part, because learning is situated and occurs through a process of hypothesizing, probing, and reflecting upon the simulated world within the game. In addition, the goals are clear, and information becomes available to players at just the time that it is needed to reach each goal. Making sense of that information becomes a goal intrinsic to gameplay. As McGonigal (2011) observed:

> *"In a good computer or video game you're always playing on the very edge of your skill level, always on the brink of falling off. When you do fall off, you feel the urge to climb back on. That's because there is virtually nothing as engaging as this state of working at the very limits of your ability. (p. 24)"*

Computer games have been observed to scaffold learning in ways that keeps players at the edge of their seats fostering continued interest in the game for hours, weeks, and even years. Players hone their skills and build knowledge as long as they continue to play. In some rare cases game developers, such as Valve (see Valve 2007, 2011), have described their effective design framework of "layered learning" which attempts to optimize learning elements consistent with interrelated principles of challenge, skills, engagement and immersion. In this framework,

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engagement and learning are necessary to keep players progressing in the game, and visa-versa. Entertainment game developers, however, are less concerned with how the learning may transfer to the outside world.

This study contributes to the current body of literature on learning by investigating the above mentioned psychological factors of challenges, skills, engagement and immersion that have been commonly believed to be characteristic to a good game and learning experiences. In the study, we investigated the relationship among these variables, and the extent to which they predict learning, in physics-based video games. The study also allowed us to explore the extent to which engagement and immersion may mediate the effect of challenges and skills on learning, as predicted by a theory of flow experiences (Csikszentmihalyi, 1990). Drawing on flow theory, perceived challenge and skills (the main two elements of flow) are hypothesized to predict engagement and immersion, which in turn are believed to predict perceived learning. We utilized a psychometric survey (see e.g. Nunnally, 1978) asking participants about their subjective learning experience after playing two video games designed by two research teams in the U.S. We then employed structural equation modeling in order to investigate these direct and mediated effects among flow (skill and challenge), engagement, immersion, and learning outcomes. The following research questions were examined:

1. Do challenge and skills predict engagement and immersion in game-based learning?
2. Do engagement and immersion predict perceived learning in game-based learning?
3. How engagement and immersion mediate the effect of challenge and skills on perceived learning in game-based learning?

1.1. Flow, engagement, and immersion in game-based learning

Serious games, gamification and game-based learning are distinct from entertainment-oriented games in that, while they are often also enjoyable, they are designed for primary end purposes other than entertainment and leisure (Davidson, 2008; Hamari & Koivisto, 2015b). Educational games, the focus of this study, are developed for the primary purpose of educating or training. Serious and educational games often combine the concentration demanded by challenging activities and the enjoyment experienced when maximally utilizing one's skills, as in “serious play” or “playful work” (Csikszentmihalyi & Schneider, 2000).

The integration of work and play characterizes the psychological state that Csikszentmihalyi (1990) has called “flow.” Flow refers to a state of mind characterized by focused concentration and elevated enjoyment during intrinsically interesting activities (Shernoff, Csikszentmihalyi, Schneider, & Shernoff, 2003).

Research on flow in general has found that utilizing high degrees of skills in challenging tasks results in deep concentration, absorption, or immersion. Flow has also been related to learning, talent-development, academic achievement, and creative accomplishment in a profession (Csikszentmihalyi, 1996; Csikszentmihalyi, Rathunde, & Whalen, 1993). In the game-based learning and gamification contexts specifically, studies predict that learning and gamified curricula will become more and more commonplace as a method to invoke engagement and flow in students (Crisp, 2014). Moreover, studies have found these technologies do indeed invoke flow experiences (Hamari & Koivisto, 2014; Procci, Singer, Levy, & Bowers, 2012) and have the potential to affect consequent learning outcomes (Barzilai & Blau, 2014; Brom et al., 2014a; Chang, Wu, Weng, & Sung, 2012; Hung, Sun, & Yu, 2015; Liu, Cheng, & Huang, 2011; Sabourin & Lester, 2014) although there are also studies that find no significant association (e.g. Brom, Bromová, Děchtěrenko, Buchtová, & Pergel, 2014b). Therefore, investigating the structure of this phenomenon is essential. Specifically, what are conditions theorized as essential to flow experienced by players of games, to what extent do such conditions lead to greater engagement and immersion, and to what extent are conditions for flow and the engagement or immersion that these conditions may engender relate to learning through the game.

The subjective experience of flow, according to Csikszentmihalyi's (1990) theory, is enhanced by certain experiential conditions or properties of the task. The most central condition for flow experiences to occur is that the individual uses a high level of skill to meet a significant challenge. The activity is therefore not too easy for one's skills, nor is it impossibly difficult. Reaching the goal is doable: one has a reasonable chance of success with sincere and concerted effort. Typically, the challenge and skill are high and in balance—individuals stretch their skills to their limits in pursuit of a challenging goal. The various combinations of high or low challenges and skills predict distinct psychological states: (a) apathy, resulting from low challenge and low skill; (b) relaxation, resulting from high skill but low challenge; (c) anxiety, resulting from high challenge but low skill; and (d) flow, resulting from high challenge combined with high skill. This model later evolved into one with eight flow channels including four intermediary or transitional states between these four quadrants (Strati, Shernoff, & Kackar, 2012).

1.2. Challenge and skills in game-based learning

According to both Csikszentmihalyi's (1990) and Bronfenbrenner's (1979) theory, more cognitively complex and challenging classwork engages students more deeply. Research corroborates this theoretical stance, demonstrating that students are significantly more engaged and concentrate much harder when challenged in classrooms. The challenge-skill dynamic has also been found to increases motivation while extending players' capacities (Fullagar, Knight, & Sovern, 2013). When invited to engage in complex problem solving instead of confronting topics only superficially, students see more connections, becoming more intrinsically interested, and thus also pay better attention. Newmann (1992) referred to curriculum that fosters higher order thinking skills and is perceived as relevant as “authentic,” but found authentic curricula in schools to be rare. Although some students might perceive being challenged as arduous and unpleasant, most students state that they like challenging work, value cognitive complexity, and are willing to work hard to complete schoolwork that challenges them (Newmann, Wehlage, & Lamborn, 1992). Conversely, national studies have repeatedly found that lack of challenge is a common reason for disengagement (Shernoff, 2010; 2013; Yazzie-Mintz, 2007).

Research has also shown that students have higher motivation, via greater self-efficacy and self-worth, when they perceived themselves to be competent (Covington, 1985). Perceptions of skill and competence have long been considered one of the most important determinants of achievement expectations, motivation, and behavior (Nicholls, 1979; White, 1959). Because success is positively valued and failure is negatively valued, people are inherently motivated and engaged to produce the feeling of competency. Some have argued that the perception of their competence and how it relates to perceived chances of success is a fundamental motivator for learning (Thomas, 1980), contributing to continuing motivation and global self-worth. Conversely, many students may feel at least somewhat uncomfortable or insecure as a function of perceived incompetence, resulting in a reluctance to take risks or take on new challenges that might increase competencies.

Engagement resembling flow experiences reflect a state of complete absorption in a challenging activity with no psychic energy left for distractions. All attention is focused on relevant stimuli.