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From duels to classroom competition: Social competition and learning in educational videogames within different group sizes

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ABSTRACT

Competition with other players or with the game itself is one of the basic elements of videogames, but the fine balance between increased mental effort and potential motivational benefits has to be addressed. A quantitative experiment was conducted to verify if social competition increases cognitive load, engagement, interest, and subsequently learning. The 115 students played an educational videogame, specifically designed for this experiment using *Minecraft*, in single, one-versus-one, small group, or classroom settings. The results show significantly higher cognitive load induced through social competition; lowered focused attention, instructional efficiency; and no higher situational interest. Additionally, increased learning in the solo condition could be observed. In contrast to these results, analysis of the actual perceived challenge resulted in positive correlations with engagement, situational interest, and retention knowledge. After the analysis, a detailed discussion of the impacts of social competition and various implications and future directions are provided. For example, it is argued that it is important to distinguish between the added gameplay mechanic of social competition and the perceived intrapersonal challenge this induces. Whereas the first might increase cognitive load due to the monitoring of additional game states, the latter might foster motivation and interest.

1. Introduction

Despite all of their technical limitations, even many of the very first popular videogames (e.g., Pong, 1972) and video consoles of the 8-bit area in the 1980s (e.g., Nintendo Entertainment System) featured gaming with two or more players, but these social interactions were limited to local systems with only a few participants. This trend was stable up until the 1990s, but has changed drastically ever since massive multiplayer games like Ultima Online (1997) used the advanced technologies of home computers and successfully demonstrated that large-scale social gaming can be a successful videogame principle. Network technology overcame technological barriers that had limited the development of hardware and software since the 1970s, and videogames experienced a profound reorientation toward more social interactions, especially during the last decade (Trefry, 2010). Social gaming has become a major trend in the videogame industry, which covers almost every genre and target group (e.g., like social networks, Farmville, 2009; casual gaming, Puzzle Pirates, 2003; core gamers, Destiny, 2014; or advanced concepts like Foldit [beta] that try to utilize the emergent effects of collaboration). Paradigmatically, smartphone applications showed how overcoming the technical and social barrier of competition tremendously boosts the game's impact. This can be observed in games like Quizkampen (2012), where players answer trivia questions and compete with friends or other players around the world. Millions of users playing an educational videogame, voluntarily answering questions about biology, culture, and history while also having fun, sounds like a dream come true for the educationist.

The fascinating motivational aspect of social competition was pointed out by the game designer Gregory Trefry, who stated as follows: “After all, winning a single-player game feels like an accomplishment; beating your friends feels like a triumph” (2010, p. 234). Although single-player games certainly will not cease to exist (Schell, 2008), the attribute of competition in different group constellations seems to be one of the important factors in videogame development and should not be ignored in research analyzing the learning potential of videogames. Therefore, we will

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outline the role of competition as a core game mechanic and its effects on learning. Additionally, we will discuss issues of competitive features in learning contexts and the challenge of implementing different group sizes in general. After completing this literature review, we then describe an empirical study to analyze the effects of social competitive gameplay within different group scenarios and discuss the results in depth.

2. Literature review

2.1. The mechanic of competition

Festinger (1954) concluded in his theory of social comparison processes that if members of a social group detect a discrepancy in abilities or opinions, they will take action to reduce these. Additionally, he described a *unidirectional drive upwards* for abilities, which implies that it is culturally desirable to increase performance. Following these thoughts, Festinger stated that competitive behavior (i.e., efforts to increase ability or to protect one's superiority) is a manifestation of social comparisons. Competitive videogame mechanics use this simple principle ingeniously as they ensure that there will always be a discrepancy to reduce, a rank to climb, or a state to defend. The players have to accomplish mutually exclusive goals (e.g., score the most points, cross the finish line first, own the castle), which results in conflicting interests (Adams, 2013) and prevents quiescence. The following four goal structures can be derived following this goal-oriented view on social interactions (Johnson, Maruyama, Johnson, Nelson, & Skon, 1981): cooperation (shared goals); cooperation with intergroup competition (shared goals in groups, but exclusive goals between them); interpersonal competition (completely exclusive goals); and individualistic efforts (independent goals). Later research added additional types of competition to this assortment as different facets of competition aroused attention. For example, relative distance or anonymity (Yu, 2003) was thought to be a factor in competition. In addition to these types of social competition, videogames include artificial competition as players always have to interact with the game system itself (Fullerton, 2014; Koster, 2011): a single player versus the game system; multiple individual players versus the game system; and players versus each other and the system. This supports the point of view that videogames are competitive by nature, as the player interacts in a competitive environment (Salen & Zimmerman, 2004; Waddell & Peng, 2014), and even cooperative games are competitive as the players are forced to cooperate in order to beat at least the game itself (Zagal, Nussbaum, & Rosas, 2000).

The importance of competition can be further emphasized from a game designer perspective. Salen and Zimmerman observed that “the competitive striving toward a goal is fundamental in giving shape to the structure of a game and the way that the game creates meaning” (2004, p. 255). Competition induces conflict, which is one of the core components of videogames in general. The basic game principles of the valorization of different outcomes and the attachment of the player to these outcomes (Juul, 2003) harness underlying comparison processes and the competitive strive upwards. Despite these core procedures induced through competition that ensure that the activity can be considered “gaming” at all, there are further functions competition can fulfill in game design. For example, competition may provide support to balance the game; human opponents may provide worthy enemies; and competitive features may allow the use of complex strategies because of the intelligence and creativity of other players compared to an artificial intelligence (Schell, 2008). Additionally, competitive gameplay can be used to provide a clear goal (Cheng, Wu, Liao, & Chan, 2009), which might be especially important in light of recent research on goals in educational videogames (e.g., Nebel, Schneider, Schledjewski, & Rey, Manuscript submitted for publication). These useful functions and the central role it plays in gaming highlight the importance of analyzing competition in videogames in general and in videogames for educational purposes as well.

2.2. Effects of competition

Social learning in videogames is suspected to be beneficial (Bopp, 2006), particularly since group interactions without competition already have the potential to trigger interest (Hidi & Renninger, 2006), and sometimes even the bare presence of others is sufficient to elicit positive effects (e.g., social facilitation, Bond & Titus, 1983; Markus, 1978; Zajonc, 1965). In addition to its crucial importance in the mechanics of gaming itself, competition evokes several cognitive and affective effects. The salient social comparisons increase the perceived importance of ability and decrease mastery or achievement orientation (Ames, 1984). Competition increases enjoyment (Fu, Wu, & Ho, 2009; Vorderer, Hartmann, & Klimmt, 2003), which can be an important factor especially for inexperienced learners (Chen, 2014b). Furthermore, intrinsic (interpersonal) motivation (Malone & Lepper, 1987), attention, excitement, and involvement (Vandercruysse, Vandewaetere, Cornillie, & Clarebout, 2013) are all affected. Especially increased motivation might affect learning as it is related to higher accuracy and more time spend on knowledge tasks within the game (Ozcelik, Cagiltay, & Ozcelik, 2013). Competition demands faster and less carefully produced actions and increases the activation of the prefrontal cortex in comparison with cooperation (Staiano, Abraham, & Calvert, 2012). Competition also triggers interest (Plass et al., 2013), which fosters attention, persistence, effort, academic motivation (Hidi & Renninger, 2006), and cognitive-behavioral-emotional engagement (Sun & Rueda, 2012), an important foundation in the experience of *flow* (Admiraal, Huizenga, Akkerman, & Dam, 2011; Csikszentmihalyi & LeFevre, 1989). But the impact of situational interest on learning outcomes might be further moderated by prior experience (Magner, Schwonke, Aleven, Popescu, & Renkl, 2014). This combination of interest and other motivational factors might be especially important because interest has to be transferred into learning behavior (Rotgans & Schmidt, 2011). Although competition supports learning (Cagiltay, Ozcelik, & Ozcelik, 2015) and fosters the development of analytic skills (Fu et al., 2009), it might inhibit metacognitive skills (Van Eck & Dempsey, 2002), which suggests stronger beneficial effects on retention tasks (DeLeeuw & Mayer, 2011). This assumption is supported by the cognitive load theory (CLT; Sweller, van Merrienboer, & Paas, 1998), a theoretical framework that highlights the importance of reducing unnecessary (extraneous) cognitive load in order to increase (germane) cognitive load relevant for learning and subsequent learning performance. Social comparisons and the monitoring of each and every competitor increase extraneous processing, which might only be compensated in regard to learning because of the beneficial motivational effects of competition (DeLeeuw & Mayer, 2011). Thus, adding social competition as an additional challenging element can be classified as a more-is-more approach (Mayer, 2014), that aims to motivate learners to engage in generative processing of educational content but might also increase extraneous processing of irrelevant game states. Following these results, there might be a lot more moderators of the effects of competition (e.g., type of task, resource sharing, task interdependence, contact allowed, reward, D. W. Johnson et al., 1981) and interactions with gameplay mechanics than already discovered and evaluated in educational videogame research. And even if the