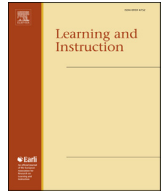




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The perception of control as a predictor of emotional trends during gameplay

Claudia Schrader ^{a,*}, Ulrike Nett ^b

^a Ulm University, Institute of Psychology, Albert-Einstein Allee 47, 89081 Ulm, Germany

^b University of Augsburg, Germany

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ABSTRACT

The present study investigated the effect of perceived control on trends of discrete achievement emotions during learning using a tower defense game designed for teaching human liver functionalities. A total of 124 students ($M_{\text{age}} = 22.89$ years; $SD_{\text{age}} = 3.01$ years; 54.8% female) were randomly assigned to play one of three game versions (high, moderate or reduced control condition). The perception of control and achievement emotions, namely enjoyment, boredom, anger, and frustration, were assessed via questionnaire after each of three rounds of gameplay. Overall, autoregressive model analysis results revealed a significant relationship between control perception and each emotion in every round of play. Moreover, a closer look at the different game versions revealed significant interactions between game versions and rounds of play for control perception and for each of the four emotions. Compared to students in the game version with reduced control, students in the high and moderate control game version reported a higher perception of control and enjoyment and lower frustration and anger. However, these effects were not persistent over time of gameplay, which indicated an increase in gameplay competencies. As both the perception of control and discrete emotions dynamically change over time, an auto-dynamic adaptation of provided control to the actual changes and needs of players is a consideration for future research.

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1. Introduction

The potential of serious games as multimedia learning tools is recognised as a possibility for offering experiences “in which participants learn through a grammar of doing and being” (Squire, 2006, p. 24). By enabling students to become engaged and to take control over their own learning through the challenging and interactive nature of games, gameplay is generally linked with the positive emotion of enjoyment (Vorderer, Klimmt, & Ritterfeld, 2004). Generating enjoyment is considered one of the key determinants in the potential for learning from games (Anolli, Mantovani, Confalonieri, Ascolese, & Peverie, 2010). Ideally, when learning through playing, the player undergoes a pleasurable experience that leads to knowledge and skill acquisition (Graesser, Chipman, Leeming, & Biedenbach, 2009). However, research (e.g., Rodrigo & Baker, 2011b; Wong et al., 2007) has indicated that a

positive emotional response does not necessarily follow active engagement in a game.

Appraisal theory approaches such as the control-value theory of achievement emotions (Pekrun, 2000, 2006) might explain the differing results concerning emotions and games. According to these approaches, in the context of classroom learning emotions are experienced as a function of learners' perceived control and the value of the current learning and achievement situation. In line with these theoretical assumptions as well as findings from Respondek, Seufert, Stupnisky and Nett (2017) in academic contexts, one could conclude that, in a learning situation the learner will more probably experience enjoyment if he or she also perceives a high level of control. According to this, one could assume that with a reduced level of perceived control, anger and frustration are more likely the emotions that arise. Adapting these findings to situations when learning with serious games, emotions during game play may be a function of the challenge that a game provides players linked with players' actual perception of being in control.

Thus, in the current research, the influence of perceived control on achievement emotions was investigated. Achievement emotions

* Corresponding author.

E-mail addresses: Claudia.Schrader@uni-ulm.de (C. Schrader), Ulrike.Nett@phil.uni-augsburg.de (U. Nett).

are defined as emotions that are directly linked to learning achievement (Pekrun, 2000; Pekrun, Elliot, & Maier, 2006). By manipulating participants' perception of control through the games' design, it was possible to examine the differences in the reporting experiences of the more prominent achievement emotions, namely enjoyment, which is positively valenced, as well as boredom, anger and frustration, which are negatively valenced. These emotions and the perception of control over rounds of play were assessed in order to explain how different levels of control perception are responsible for differences in the experience of each emotion.

The findings may lead to practical implications from a human-computer interaction point of view. Achievement emotions in educational settings have been shown to foster engagement and learning as demonstrated in research in the fields of psychology (e.g., Dweck, 2000), education (e.g., Meyer & Turner, 2006; Schutz & Pekrun, 2007) and clinical neuropsychology (e.g., Cowley, Ravaja, & Heikura, 2013). These studies have provided evidence that emotional trends are linked to learners' appraisal in response to the design of learning material and highlight the importance of design adaptation in order to induce and regulate particular emotional states.

2. Theoretical background

2.1. Emotions during learning with serious games

As reported in various studies, gaming is one of the preferred leisure activities among children and youth (for an overview of studies see the literature review by Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012). The main motives of players for playing games are to improve one's mood, to generate positive emotions, and to fight boredom. Theoretical gaming approaches such as those of Oerter (1999) and Vorderer et al. (2004) incorporate enjoyment as the main benefit of playing games.

As emotions are linked to learning by affecting the use of cognitive resources and the way information is processed and stored into long-term memory, learners are more willing to invest mental effort into enjoyable learning activities such as gaming rather than boring or frustration-inducing activities. Enjoyment directs attention (Meinhardt & Pekrun, 2003) and facilitates recall (Isen, Shalcker, Clark, & Karp, 1978). Boredom and frustration are in some cases negatively correlated with learning (Pekrun, Goetz, Frenzel, Barchfeld, & Perry, 2011) because bored or frustrated learners have trouble focussing attention and persisting in given tasks.

A number of studies have indeed found that learning with serious games can result in greater enjoyment and better learning outcomes compared to other media (e.g., Barab, Arici, & Jackson, 2005; Ricci, Salas, & Cannon-Bowers, 1996). In contrast, Rodrigo and Baker (2011a) who examined teenagers who learned math with a game versus an intelligent tutor system found the incidence of negative affect (boredom and frustration) was higher for gameplay compared to learning with a tutor system. Furthermore, they found that students who learned with the tutor system spent significantly more time engaged with the learning material. By comparing a game, replay, hypertext and printed text, Wong et al. (2007) reported similar effects. Whereas the game used in this study was perceived as more enjoyable compared to traditional text, non-significant differences were found between the game and the hypertext version. Further, non-significant differences in learning gains were found between all conditions.

These disparate findings demonstrate that gaming can have benefits of positive emotions and enhance learning performance, but can also result in negative emotional responses.

The studies also underscore the need for further research to determine the specific conditions when achievement emotions, both positive and negative, appear during gameplay. The existing research lacks experimental studies that go beyond the influence of games as a whole. Because serious games are available in a variety of forms with diverse features, it is difficult to draw conclusions about the influence of games on emotions. Focussing on the impact of gaming characteristics rather than on the games in general should be explored. The crucial question for serious games, therefore, is not whether serious games would be more enjoyable as other educational media, but rather what specific design features contribute to different emotional responses. Ravaja et al. (2004), for example, compared the effect of entertainment games by examining differences in the point of view from which the game is played and the amount of violence on players' emotional responses. Participants who played a less violent game reported significantly more positively valenced emotional responses compared to those who played a more violent game. To our knowledge, there is no research on the concrete impact of specific design features on players' changes in emotional trends, at least not in regard to serious games.

Existing studies have tended to retrospectively measure participants' emotional states (e.g., Barab et al., 2005; Wong et al., 2007); however, it is critical to avoid focussing only on retrospective assessment in order to understand how students perceive and give meaning to a current situation (Op't Eynde & Turner, 2006). By measuring trends of emotions during learning processes, research in the context of intelligent tutoring (e.g., D'Mello & Graesser, 2011), for example, demonstrated that a broader range of emotions can occur during learning at the same time and that these are dynamic. Thus, rather than retrospectively measuring emotions, there is a need for systematic research identifying the current trend of players' emotional experiences during learning with serious games. Therefore, the focus of this study is on the impact of game design on the trends of players' emotional states processed during learning in serious games and the consequences for performance. This can shed light on the dynamics of emotions during gameplay and may also serve as a useful first step in determining whether and when an adaptive change in specific design characteristics is needed for subsequent game tuning in order to achieve an optimal gameplay experience and performance.

2.2. The interplay between the perception of control and emotions

An important consideration in the current study is the effect of design features on achievement emotions and their trends during learning with serious games. Control is seen as one of the key design features in games that trigger emotions (Grodal, 2000; Jabbar & Felicia, 2015). From a technological perspective, control is defined as the potential of any medium to allow users to handle control devices flexibly and intuitively (Bryant & Love, 1996). Besides the technical perspective, game design features, such as such as the extent users are allowed to manage direction of gameplay activities, and the number and pace of game elements that have to be handled at the same time while playing define the amount of control (Alkhafaji, Grey, & Hastings, 2013). In addition to the concept of control being an attribute of a medium itself, control can also be defined as a psychological factor given that the extent of control allowed by a medium is a function of the individual's perception of control, which reflects the user's competence to influence a medium, or at least to master certain aspects of it (Klimmt, Hartmann, & Frey, 2007). As such, users' perception of control can be seen as an outcome of the relation between the provided challenges and user's experience of fulfilling these challenges (Chen, Wigand, & Nilan, 1999). Wang, Shen, and Ritterfeld

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