Learning and Instruction 58 (2018) 42–52

Contents lists available at ScienceDirect

Learning and Instruction

journal homepage: www.elsevier.com/locate/learninstruc

Learning-related emotions in multimedia learning: An application of control-value theory

Lisa Stark*, Elisa Malkmus, Robin Stark, Roland Brünken, Babette Park

Department of Education, Saarland University, Saarbrücken, Germany

ARTICLE INFO

Keywords:
Multimedia learning
Control-value Theory
Achievement emotions
Value induction
Learner Control

ABSTRACT

The present study investigated assumptions of *Control-value Theory of Achievement Emotions* in multimedia learning. By applying an experimental 2x2-factorial between-subject design, the factors learner control (high vs. low) and value induction (high vs. low) were systematically varied. Results showed that high learner control led to higher perceived control and higher learning outcomes. There were no main effects of value induction. Significant interaction effects showed that the group with induction of a high positive task value and high learner control had most positive learning-related emotions and highest learning outcomes. Serial mediation analyses revealed that the main effect of learner control on learning outcomes was serially mediated by perceived control, learning-related emotions, and use of cognitive resources. The interaction effect on learning outcomes was serially mediated by control and value appraisals, learning-related emotions, and use of cognitive resources, as well. In particular, the results of the serial mediation analyses support assumptions of Control-value Theory and its validity in an experimental setting.

1. Introduction

In the past decade, multimedia learning research has started integrating affective factors and emotions in research and theory building (Moreno & Mayer, 2007; Park, Plass, & Brünken, 2014). Until now, most empirical studies in this field have focused either on effects of prevailing emotional states before learning (e.g. Knörzer, Brünken, & Park, 2016) or on effects of emotional design elements in multimedia instruction (e.g. Mayer & Estrella, 2014; Park, Knörzer, Plass, & Brünken, 2015; Stark, Park, & Brünken, 2018). However, non-emotional design elements, such as learner control (Scheiter, 2014), have not yet been investigated with regard to the effect on learners' emotions (for an exception see Park, Flowerday, & Brünken, 2015).

In addition, recent studies on emotions in multimedia learning focused on *general* emotional states, like happiness or sadness. In some studies, especially studies on emotional design, there were small or even null effects on emotional states (e.g., Heidig, Müller, & Reichelt, 2015; Park, Knörzer et al., 2015). However, assessment of general emotional states, which rely on one's own judgments about rather global experiences of a situation might not have been sensitive enough to record changes induced by emotional design. Therefore, *learning-related* emotions, which are directly linked to the learning process (Pekrun, 2006), might be more promising for capturing emotional reactions with regard to design elements of multimedia instruction. These kinds of emotions have not yet been integrated in multimedia learning research, but rather they have been investigated in correlational settings of field studies in schools (e.g., Pekrun, Goetz, Titz, & Perry, 2002). Therefore, the present study aims to bridge the gap between theory of learning-related emotions, i.e., *Control-value Theory of Achievement Emotions* (Pekrun & Perry, 2014, pp. 120–141; Pekrun, 2006), and experimental multimedia learning research.

In the present study, assumptions of Control-value Theory are transcribed into an experimental study design and are investigated with regard to their validity and applicability. Learning-related emotions are induced by means of value induction and provision of learner control (pace control) in a multimedia learning environment. Effects on subjective control and value appraisals, positive and negative learning-related emotions, use of cognitive resources, and multimedia learning outcomes are investigated in analyses of variance and serial mediation.

2. Theoretical background

2.1. Multimedia learning

Multimedia learning refers to learning from multimedia instruction, which is defined as learning environments containing a combined presentation of words and pictures (e.g., schoolbooks, online learning games; Mayer, 2014). *Cognitive-affective Theory of Learning with Media*

* Corresponding author. Saarland University, Department of Education, Campus A4 2, 66123, Saarbrücken, Germany.
E-mail address: lisa.stark@uni-saarland.de (L. Stark).

https://doi.org/10.1016/j.learninstruc.2018.05.003
Received 27 September 2017; Received in revised form 4 May 2018; Accepted 11 May 2018

(CATLM; Moreno & Mayer, 2007) conceptualizes multimedia learning in a framework combining cognitive and affective aspects. According to this theoretical framework learning takes place by actively processing incoming verbal and non-verbal information in two independent information processing channels within the working memory (Baddeley, 2007). These channels are limited in their capacities (Sweller, 2010), but they are capable of processing information simultaneously and coding it dually (Sadoski & Paivio, 2013). Further, CATLM states three factors which have an additional impact on multimedia learning: (1) affective and motivational factors; (2) meta-cognitive and self-regulatory skills, and (3) learner characteristics (e.g., prior knowledge), all of which affect information processing during multimedia learning.

The present study focuses on the assumption regarding affective factors mediating multimedia learning. However, this assumption of CATLM does not specify which kind of emotions (e.g., general or learning-related) are assumed to influence multimedia learning and how exactly this relationship is constituted. In this respect, further theoretical considerations regarding theory of learning-related emotions might be fruitful.

2.2. Control-value Theory of Achievement Emotions

Emotions can be defined as multi-faceted phenomena (Scherer, 1990), which can be evoked by certain stimuli and evolve from individual's appraisals of these stimuli. Achievement emotions refer to emotions related to learning and achievement (Pekrun, 2006), whereas learning-related emotions constitute a subgroup. Analogous to taxonomies of general emotional states (e.g., Russell, 2003), learning-related emotions can be differentiated by their *valence*, ranging from negative to positive as well as their degree of activation (deactivating – activating; Pekrun, 2006). For the present study, we focus on the valence dimension by differentiating between positive and negative learning-related emotions.

Control-value Theory of Achievement Emotions (CVT; Pekrun, 2006; Pekrun & Perry, 2014, pp. 120–141) describes antecedents and consequences of achievement emotions. Achievement emotions evolve from learner's control and value appraisals, which are amongst other factors determined by characteristics of the learning situation. Control appraisals refer to the learners' judgments about the perceived controllability of learning activities and results, which can range from low to high. For example, learners who perceive high control experience themselves to be in a position to perform learning activities with the desired outcomes. Value appraisals describe learners' ascribed value of the task or outcome, e.g., how important the task is for themselves. Positive and negative values can be distinguished alongside dimensional approaches, postulating that perceived positive and negative task value can range from low to high (Frenzel, Götz, & Pekrun, 2009). With regard to the development of emotions, control appraisals are positively correlated with positive learning-related emotions and negatively correlated with negative learning-related emotions (Pekrun et al., 2002, 2011). As control and value appraisals are assumed to have a multiplicative impact on emotions, high value appraisals are associated with more intense learning-related emotions especially when perceived control is high (Frenzel et al., 2009; Pekrun, 2006). As previously stated, control and value appraisals are assumed to be determined amongst other factors by characteristics of the learning environment (Pekrun, 2006). For example, CVT postulates that providing autonomy during learning, e.g., by means of providing learner control over pace will lead to higher control appraisals and therefore to more positive learning-related emotions. A value induction, e.g., telling learners why a task is important to them, is assumed to induce respective value appraisals, which in turn will affect learning-related emotions. These assumptions are supported by empirical evidence (e.g., Pekrun et al., 2002). Furthermore, CVT postulates that positive achievement emotions are assumed to be beneficial to learning whereas negative achievement emotions are assumed to impair successful learning. Concerning mechanisms of action, CVT states that the impact of learning-related emotions on learning outcomes is mediated by specific variables related to information processing. One of these variables is learners' use of cognitive resources. Successful and conscious use of cognitive resources converges with greater learning progress and higher learning outcomes (Choi, Van Merriënboer, & Paas, 2014; Kalyuga, 2011; Sweller, 2010). There is already evidence that learners' emotional states affect use of cognitive resources during learning processes (Fraser et al., 2012; Knörzer et al., 2016; Smith & Ayres, 2014). Furthermore, beneficial and impairing effects of positive and negative (learning-related) emotions on learning outcomes were shown in numerous studies (e.g., Pekrun et al., 2002).

The above addressed assumptions of CVT have been empirically confirmed in numerous correlational studies (e.g., Goetz, Pekrun, Hall, & Haag, 2006; Pekrun et al., 2011; Pekrun et al., 2002). However, these studies do not allow for causal relationships between the postulated constructs and achievement emotions to be inferred. Thus, until now, the question has not been answered, whether assumptions of this theory also hold in experimental settings.

To our knowledge, there is only *one* study testing assumptions of CVT in an experimental setting, which was carried out in the research field of learning from texts (Mills, D'Mello, & Kopp, 2015). In that study, composed of a 2x2-within-subject design, participants were confronted with four different texts to learn. The control component of CVT was indirectly manipulated by applying texts of high vs. low difficulty, which were assumed to induce low vs. high control. Further, participants were made to believe that failing to score high enough on tests evaluating learning performance would be punished by having to read more texts. High vs. low task value (consequence value) was induced by indicating that texts have a major vs. minor impact on scoring specifically with regard to impending punishment. It has to be noted, that in the study in question high consequence value resembled a highly negative value so that it was assumed to result in more negative achievement emotions. Contrary to assumptions of CVT, these negative achievement emotions were hypothesized to lead to better learning outcomes. Results confirmed that the applied value induction led to more negative achievement emotions as hypothesized, whereas the control manipulation was not associated with achievement emotions. Further analyses showed that the beneficial effect of the value induction on learning performance was mediated by achievement emotions especially in conditions with low control.

Even though those results are promising for conducting a similar study on multimedia learning, there are some issues which should be reconsidered regarding the experimental manipulation. Control was induced *indirectly* by the manipulation of task difficulty, so that may be a reason as to why no effects on achievement emotions were detected. Further, induced value referred to consequence value. The applied negative value type can be regarded as an induction of pressure, i.e., induction of negative achievement emotions. Even though the study by Mills, D'Mello, and Kopp (2015) showed that negative emotions can be beneficial to learning, the induction of positive task value and, thereby, positive achievement emotions seems to be more appropriate for promoting deeper information processing and sustainable learning (Hidi, 2001). In addition, learners' appraisals as direct antecedents of achievement emotions were neither addressed in manipulation checks nor integrated in a serial mediation linking appraisals, emotions, and learning performance.

Therefore, the present study applies *direct* manipulation of control and induction of a *positive* task value for testing assumptions of CVT. Furthermore, *serial mediation* analysis is integrated to test the assumption of how the manipulations of control and task value are linked to control and value appraisals, emotions, use of cognitive resources, and learning. From this point onward the phrase task value will be used when referring to positive task value.