The autonomy-enhancing effects of choice on cognitive load, motivation and learning with digital media

Sascha Schneider*, Steve Nebel, Maik Beege, Günter Daniel Rey

Psychology of Learning with Digital Media, Faculty of Humanities, Chemnitz University of Technology, Straße der Nationen 12, 09111, Chemnitz, Germany

A B S T R A C T

According to the Self-Determination Theory, the autonomy-supporting feature of choice leads to an increase in intrinsically motivated behavior. Although this effect was replicated multiple times, instructional designers often dread to include choice options in single tasks because of the high effort in designing additional materials or a higher cognitive load for students. This study used a *feigned choice paradigm* to avoid additional efforts for designers. Moreover, this study examined the mediational influences of learners' perceived autonomy and intrinsic motivation on choice effects and the moderating influence of the *relevance of choice options*. In Experiment 1, 79 secondary school students were randomly assigned to either a group with a feigned topic choice or a group without the possibility to choose. Results show that both retention and transfer performance (learning scores) were enhanced by choice options. In addition, the effect of choice on retention was mediated by perceived autonomy but not by intrinsic motivation. In Experiment 2, 87 secondary school students were assigned to a 2 (with or without a feigned learning-relevant choice) x 2 (with or without a feigned learning-irrelevant choice) design in order to additionally examine the moderating effects of relevance of choice options. All results of Experiment 1 were replicated for the inclusion of learning-relevant choices, whereas irrelevant choices were not found to significantly impact scores of transfer and external regulation. Interestingly, all students with a choice reported a lower intrinsic load, although the complexity of the learning tasks was kept constant.

1. Introduction

New technologies often promise an individualization of learning processes. However, when reading tasks are presented to learners at computers, their motivation to join and keep working on tasks can fade quite rapidly. In this context, highly motivated learners tend to keep working longer than learners with a low motivation (Martens, Gulikers, & Bastiaens, 2004). For this, specific design principles enhancing a learner's motivation during tasks are needed. According to the *self-determination theory* (SDT; Deci, 1980; Ryan & Deci, 2000), features enhancing the students' perception of competence, relatedness or autonomy can help to increase the motivation to learn. In computer-based environments, limited choice options, as one component to increase the feeling of autonomy, was found to be a main problem (Hartnett, 2015). In conclusion, providing choice might be a powerful tool for educators to increase a learner's autonomy in task-specific behavior and finally his or her motivation to engage in learning. Indeed, motivation-enhancing effects of choice received multiple empirical (e.g., van Loon, Ros, & Martens, 2012) and meta-analytical support (Patall, Cooper, & Robinson, 2008).

In contrast, according to the Cognitive Load Theory (Sweller, 2016), additional information, which is not relevant for a learning goal, should be avoided in order not to overload a learners' working memory. As a result, additional instructions with choice options might inhibit the learning process. Moreover, a learning content might be restricted in its possibilities to separate choice options, or choice options might lead to a disproportionately high effort in designing additional examples or learning materials. In these cases, practitioners often dread to include choice options, thereby accepting a loss of learners' autonomy and motivation. This study aimed at examining the inclusion of choice options without changing properties of digital learning materials (feigned choice). For example, providing learners with options to choose between two sub-topics of a learning material, which are both included in a subsequent text, can be a possibility to include choice without changing the material's content. This feigned choice paradigm is important to experimentally separate choice effects from the change of instructional materials, which is given by a "real" choice. In media contexts, a feigned choice might be sufficient to evoke an increase in autonomy, motivation and learning performance without losing credibility. In addition, the learning relevance of choice options is still

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questionable, so that even learning-irrelevant choice options, like different genres of background music, might be helpful to enhance the learners' motivation. The feigned choice paradigm as well as boundary conditions of choice options were the focus of this study.

2. Motivation and task-based learning

The concept of motivation is described in the SDT, a macro theory of humans' agentic action to assimilate and integrate knowledge (Vansteenkiste, Niemiec, & Soenens, 2010). According to this theory, humans pursue basic psychological needs (i.e., *competence, autonomy* and *relatedness*) in the interaction with their environment. These needs are either supported or impeded by the environment (Deci & Ryan, 2000). The need for competence is described by the desire to effectively cope with one's environment and the following experience of a sense of competence. The need for relatedness is connected with a sense of feeling connected with others. Finally, the need for autonomy is fulfilled when humans perceive themselves as being the origin of their own actions (Deci & Ryan, 2000, 2012). Autonomous experiences are defined by a feeling of self-endorsement and congruence with the own values and interests (Vansteenkiste et al., 2010). These experiences are mainly fostered when individuals face choice and volition in their actions. When one, two or all psychological needs are met, people evaluate their behavior to be self-determined. This state is also called intrinsic motivation. In contrast, when no need is satisfied, people are in a state of amotivation (or at least in a state of external regulation) and evaluate their behavior to be nonself-determined (Ryan & Deci, 2000). For example, the inclusion of autonomy-enhancing features can lead to increase a perception of self-determination which results in an increased intrinsic motivation.

If people attribute their actions as being autonomous, their actions tend to maintain. Moreover, perceptions of autonomy are positively correlated with task engagement and perceived competence (Deci & Ryan, 2012). Since the feeling of relatedness is harder to achieve in online learning environments because of its inherent lack of a direct social interaction, while the feeling of competence is mainly affected by the results of the learning process, autonomy-enhancing features seem to be a promising approach to enhance learner's performance in task-specific motivation processes. This assumption is in line with the unified theory of task-specific motivation (UMTM; de Brabander & Martens, 2014), which distinguishes autonomy in two concepts: personal autonomy and perceived freedom. Whereby personal autonomy refers to the experience of feeling oneself as the origin of choosing and performing an action, perceived freedom is defined as the experiencing the freedom to make decisions. Providing options to choose, in this case, does not always lead to an increase in a personal autonomy, since freedom can also be experienced as a cognitive burden (de Brabander & Martens, 2014). These "cognitive costs" of choice options can be described with the Cognitive Load Theory (Sweller, 2016). According to this theory, learning materials provide two types of cognitive load. First, learners need to understand the learning material elements and their interactivity in order to form a coherent mental model, which can be integrated into long-term memory. This load is called Intrinsic Cognitive Load (ICL) and refers to learning-relevant processes. Second, learners also need to cope with learning-irrelevant processes (i.e., Extraneous Cognitive Load; ECL). These processes depend on the design of the learning material. Since learners possess a limited working memory capacity, which deals with both load types, ECL processes should be reduced to a minimum in order to save working memory capacity for learning-relevant processes. According to the CLT, included additional autonomy-enhancing features, like feigned choice options, merely lead to additional cognitive processes, which are not needed to achieve a learning goal (i.e. additional ECL processes). However, CLT does not yet include possible learning-enhancing effects of non-cognitive processes on learning.

3. Effects of choice on learning and cognitive load

People feel more autonomous when they are enabled to choose between options (Katz & Assor, 2007). The provision of choice increases the intrinsic motivation of students and their situational interest in the learning task (e.g., D'Mello, 2013; Høgheim & Reber, 2015; Høgheim & Reber, 2017; Reber, Hetland, Chen, Norman, & Kobbeltvedt, 2009; van Loon et al., 2012). This effect was also proven by a meta-analysis (Patall et al., 2008). Results show that choice is able to increase the intrinsic motivation, effort, perceived competence and task performance of learners, while subsequent learning scores were not significantly increased. There is also evidence that positive choice effects remain even for irrelevant choices or choice that appear trivial (e.g., Cordova & Lepper, 1996; Swann & Pittman, 1977). Patall (2013) stated that a provision of choice is additionally supposed to enhance learners' positive mood. A higher task value induced by choice is positively related with satisfaction and a motivation to continue with a task, whereby motivation is negatively correlated with negative emotions like boredom or frustration (Reynolds & Symons, 2001). This self-reward function of choice also found neurological evidence (Leotti & Delgado, 2011). It was also demonstrated that an increased situational interest elicited by the provision of choice promotes engagement in a learning task and leads to a higher invested mental effort (e.g., Flowerday, Schraw, & Stevens, 2004; Patall, 2013).

More recent research showed that choice can also have a restricted effect or even worsening influences. Some results show that choice is only supposed to increase positive feelings (e.g., Flowerday & Shell, 2015) and does not significantly influence learning in school (e.g., Evans & Boucher, 2015; Wijnia, Loyens, & Derous, 2011). In contrast, one case showed that a choice of learning topics was found to be a sufficient method in order to enhance learning performance (Reynolds & Symons, 2001). The researchers showed that a choice of books in a reading class can increase students' accuracy in reading and interest in the book. Other researchers additionally revealed that choice was able to enhance test scores of students in school situations (e.g., Patall, Cooper, & Wynn, 2010; Patall, Vasquez, Steingut, Trimble, & Pituch, 2017) or in motor learning tasks (e.g., Lewthwaite, Chiviacowsky, Drews, & Wulf, 2015; Post, Fairbrother, & Barros, 2011). This might be resulting from the increase of analytical thinking techniques when students were able to choose between options (Savani, Stephens, & Markus, 2017). Although there were several attempts to explain how choice effects on motivation can be explained, there are only few experiments trying to show correlational or mediational effects of autonomy or motivation on learning outcomes. In a study by Linnenbrink-Garcia, Patall, and Messersmith (2013) choice was found as a significant predictor for situational interest, whereby an increase of situational interest was found to be a mediator of increased perceived competence scores. Kusurkar, Ten Cate, Vos, Westers, and Croiset (2013) revealed that an increased autonomy can lead to an improved choice of study strategies, which then leads to an increased academic performance. In contrast, Flowerday and Shell (2015) presented results that suggest that choice is only able to increase a positive attitude, whereby this attitude is positively correlated with a knowledge test.

In fact, there is only little evidence for choice effects in the field of learning with digital learning materials. In a study by Ozogul, Johnson, Atkinson, and Reisslein (2013), one group of middle-school students were able to choose between different pedagogical agents in contrast to a group without a choice. The transfer score of the choice group was significantly greater. In contrast, their ratings of the program and their perceived difficulty were not significantly different from the no choice group. However, the researchers suggest to further examine choice in terms of autonomy ratings, motivation, cognitive perceptions and learning outcomes. In more detail, there is still a lack of studies examining the effects of choice on cognitive load. A study by Zimmerman and Shimoga (2014) in the research area of marketing has shown that cognitive load is directly connected with the task to choose between