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Effects of self-regulation prompts in hypermedia learning on learning performance and self-efficacy

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ABSTRACT

Learning with prompts activates self-regulation processes often resulting in increased learning performance. As experiences of self-regulation and learning success are sources of self-efficacy, the study investigated whether prompts affect learning performance over two learning sessions and examines whether prompts affect learners' self-efficacy perceptions within and across these sessions. N = 52 students learned twice for 30 min in a hypermedia either receiving prompts or learning without. In each session, self-efficacy was assessed before, during, and after learning while performance was measured at the end. Prompted learners outperformed learners without prompts only in the first performance test regarding transfer. Additionally, they reported higher overall self-efficacy. While self-efficacy perceptions did not differ between groups in the first learning session, self-efficacy perceptions in the second learning session were higher amongst prompted learners. Results indicate that learning with prompts may foster self-efficacy across learning sessions. Navigation behavior did not differ between groups. Underlying mechanisms and longer-term effects of prompts need to be further researched.

1. Theoretical background

Two lines of research flourished in the last decades in educational research: self-regulation and computer-based learning. In our study we address both lines of research and we are especially interested in fostering self-regulated learning in computer-based hypermedia environments through prompts. The goal is to analyze whether prompting self-regulation affects learning performance, learners' navigation behavior and also learners' self-efficacy.

1.1. *Self-regulated learning and its importance for learning in computer-based hypermedia environments*

Self-regulated learning is the first line of research, which has received attention. Zimmerman (2005) developed a model of self-regulation in which he states that „self-regulation refers to self-generated thoughts, feelings, and actions that are planned and cyclically adapted to the attainment of personal goals.“ (p. 14). Like other process models of self-regulation (e.g., Schmitz & Wiese, 2006; Winne & Hadwin, 1998), this model highlights the dynamic process of learning and hence builds the theoretical background for this study. Zimmerman (2005) describes three phases of self-regulated learning processes: forethought, performance and self-reflection. During forethought, the task is analyzed and self-motivational beliefs such as perceptions about one's self-efficacy are considered. Goals are set and cognitive learning strategies (e.g., organization, elaboration) are often selected and planned accordingly. The strategies selected during forethought are deployed during the performance phase. Additionally, learners apply self-observational metacognitive strategies such as monitoring of the learning process, i.e. assessing one's learning state in relation to one's learning goals (Bjork, Dunlosky, & Kornell, 2013). During self-reflection, self-judgmental and self-reactional processes are initiated. These include metacognitive aspects like comparing one's performance against some standards, as well as motivational and emotional aspects like attributing success or failure to a source, or the experience of performance related feelings. These phases are thought to be cyclical. Prior learning experiences affect future ones within one learning situation and across different learning situations. Thus Zimmerman (2005) views self-regulation as a process with reoccurring feedback-loops and highlights the interplay between cognitive and metacognitive strategies as well as motivational factors for self-regulation.

Self-regulated learning has been identified as an important factor associated with learning success in various learning situations (e.g., Dignath & Büttner, 2008; Hattie, Biggs, & Purdie, 1996; Panadero, Jonsson, & Botella, 2017; Samruayruen, Enriquez, Natakuatoong, & Samruayruen, 2013; Schwonke, 2015). For studying self-regulated

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learning, learning situations are needed that offer learners the possibility to pursue individual learning paths (e.g., classroom learning situations, computer-based learning; Azevedo, 2005; Schwonke, 2015). One advantage for studying self-regulated learning is offered by computer-based learning environments. They "incorporate various aspects of computer technology to assist individuals in learning for a specific educational purpose" (Winters, Greene, & Costich, 2008, p. 430). In our study we especially focus on one type of computer-based learning environments: hypermedia. They are characterized by interlinked pages or representations (hyperlinks) that offer non-linear navigation (Dillon & Jobst, 2005). Through hyperlinks, learners can pursue their individual learning path, which offers a greater degree of learner control than traditional learning material (Scheiter & Gerjets, 2007). Thus, they require active and extensive self-regulation activities from learners (Scheiter & Gerjets, 2007; Shapiro & Niederhauser, 2004). Besides this, individual learning paths and navigation behavior can be traced in hypermedia online/on-the-fly (Veenman, 2011; Winne & Perry, 2005). In contrast to traditional self-regulated learning scenarios, accessing such data online/on-the-fly is possible without putting learners in artificial learning situations (like it would be the case when learning was videotaped). Additionally, assistance to support the acquisition of learning contents (e.g., tools or scripts) can easily be integrated in hypermedia (Schwonke et al., 2013; Clarebout & Elen, 2009). In sum, hypermedia serve as a good research tool for investigating self-regulation processes in a naturalistic environment.

To investigate self-regulated learning in hypermedia, self-reports and navigation behavior data from log files are often used (Clarebout & Elen, 2009; Hadwin, Nesbit, Jamieson-Noel, Code, & Winne, 2007; Jeske, Backhaus, & Stamov Roßnagel, 2014). While learning, learners' navigation behavior can be traced by logging time, frequency and sequence of the visited or relevant pages (Bannert, Sonnenberg, Mengelkamp, & Pieger, 2015; Narciss, Proske, & Koerndle, 2007), navigation paths like forward and backward jumps (Jeske et al., 2014), and tools used (Clarebout & Elen, 2009). With respect to the navigation between pages, Bannert et al. (2015) propose that non-linear navigation is an indication of strategic navigation behavior as a conscious node selection can be an indication of goal-oriented, individual learning paths. However, Jeske et al. (2014) found that forward and backward jumps (non-linear navigation) are related to attenuated learning performance. Also Greene and Azevedo (2007) see excessive non-linear navigation as an indication of poor self-regulation and find it to be associated with poorer learning performance. Regarding time spent on relevant pages, evidence suggests that increased learning time is related to increased performance (Jeske et al., 2014; Narciss et al., 2007). In terms of self-regulation, an increased time spent on relevant aspects indicates that learners are able to differentiate between relevant and irrelevant information. Thus, whether different aspects of navigation behavior really reflect enactive self-regulated learning behavior or not, must be considered with respect to learning outcomes.

Most learners do not apply self-regulation strategies while learning in hypermedia as extensively as suggested by self-regulation researchers (Azevedo, 2009; Kauffman, Zhao, & Yang, 2011; Kramarski, 2012). For designing powerful means to foster self-regulated learning in hypermedia, it is important to understand the reason for this lack of self-regulation activities while learning. Most learners know a variety of self-regulation strategies (i.e. the strategies are available), but fail to deploy their knowledge and skills while learning (Veenman, Kerseboom, & Imthorn, 2000). Besides conditional knowledge about when certain self-regulation activities are effective, motivational beliefs influence whether and which strategies are deployed during learning. In fact, motivation has been identified as a critical factor for learning in hypermedia (Moos & Marroquin, 2010; Moos & Stewart, 2013). According to the self-regulation model (Zimmerman, 2005), learners' self-efficacy influences learning strategy selection and use.

1.2. Self-efficacy as requirement and consequence of self-regulation

Self-efficacy is defined as "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (Bandura, 1997, p. 3). It is a well-established motivational construct in the field of educational psychology (Murphy & Alexander, 2000) and also an integral motivational part of most self-regulation models including Zimmerman's (2005). In his self-regulation model, self-efficacy is one of the motivational components of forethought. Yet, self-efficacy is not an isolated variable of forethought, it affects numerous variables in all parts of the self-regulation cycle and is in turn affected by them.

The belief of being capable to understand and fulfill a task influences the motivation to engage in it (Bråten, Samuelstuen, & Strømsø, 2004; Liem, Lau, & Nie, 2008). Subsequently, strategies will be selected that are thought to lead to the desired outcome. The effects of self-efficacy can either directly affect learning strategies (e.g., Diseth, 2011) or indirectly via its effect on other motivational variables (Bråten et al., 2004; Liem et al., 2008). In a hypermedia, Moos and Azevedo (2009) investigated the effects of self-efficacy on monitoring and learning performance. They found that the relationship between self-efficacy and learning performance was mediated by monitoring. The relation was additionally confirmed by Moos (2014), where learners' self-efficacy predicted positive and negative monitoring. Facing obstacles and throwbacks, the belief in one's capability will affect leaners' vigor and persistence to fulfill the task until the desired outcome is reached (Bandura, 1997; Pajares, 1996). Moreover, self-efficacy also affects evaluative processes (Wäschle, Allgaier, Lachner, Fink, & Nückles, 2014). Hence, self-efficacy is consistently found to predict learning success (Diseth, 2011; Liem et al., 2008; Moos & Azevedo, 2009; Pajares, 1996; Sitzmann, Ely, Brown, & Bauer, 2010; Wadsworth, Husman, Duggan, & Pennington, 2007). The studies highlight the positive effects of self-efficacy on self-regulation processes during forethought, performance and self-reflection as well as on learning success. Self-efficacy, however, is not only a requirement for self-regulation, but also as a consequence of it.

That self-efficacy can be seen as a consequence of self-regulation becomes apparent when the sources of self-efficacy are considered (Bandura, 1997). Self-efficacy is shaped by four principal sources of information: social persuasion, social comparison, physiological reactions, and mastery experiences (Bandura, 1997). Enactive mastery experiences, which serve learners as valid indicators of their capability, represent a powerful source of self-efficacy. When learning, learners interpret the results of these learning experiences and form beliefs about how capable they are in managing subsequent related learning activities. Viewing past accomplishments as positive will most likely boost learners' self-efficacy. However, the opposite effect is likely when learning experiences are viewed as unsuccessful. Thus, self-efficacy perceptions develop over time and are affected by mastery experiences like learning success (Bandura, 1997; Chen & Usher, 2013; Usher & Pajares, 2008). Also the meta-analysis by Panadero et al. (2017) indicates that self-assessment methods (e.g., rubrics, self-grading) affect learners' self-efficacy. He argues that these methods help learners to gain a deeper understanding of the learning content, which increases learning performance. This in turn affects self-efficacy. Yet, also experiences of enactive self-regulation can be viewed as mastery because they show learners their repertoire of skills (Bandura, 1997; Schmitz & Wiese, 2006).

Viewing self-efficacy as a requirement and consequence within the dynamic cycle of self-regulation highlights the importance of time as a variable for investigating self-regulation processes and individual perceptions of self-regulation. In sum, self-regulation is not only affected by learners' perceived self-efficacy but also that learners' perceived self-efficacy may be affected by self-regulatory processes or their consequences.