Learning and Instruction xxx (2016) 1–11

Contents lists available at ScienceDirect

Learning and Instruction

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

Do cognitive and metacognitive processes set the stage for each other?

Julian Roelle*, Christine Nowitzki, Kirsten Berthold

Department of Psychology, Bielefeld University, P.O. Box 100131, 33501 Bielefeld, Germany

ARTICLE INFO

Article history:
Received 9 June 2015
Received in revised form
16 November 2016
Accepted 19 November 2016
Available online xxx

Keywords:
Self-regulated learning
Cognitive processes
Metacognitive processes
Learning protocols
Prompts

ABSTRACT

Cognitive and metacognitive learning processes might not only functionally complement but also set the stage for each other. To address potential stage-setting effects between these processes, we conducted two experiments in which we varied whether students were prompted to engage in the cognitive processes of organization and elaboration prior to using the metacognitive processes of comprehension monitoring and remediation planning as well as implementing their remediation plans (cognitive-first sequence), or vice versa (metacognitive-first sequence). As the medium for engaging in these processes we used learning protocols, which were performed as follow-up activity to a lecture or regular lessons. We consistently found that the learners in the metacognitive-first groups outperformed their counterparts regarding the quality of the executed organization and metacognitive processes. We conclude that cognitive and metacognitive processes can influence each other's quality; however, they do not necessarily set the stage but can also damage the stage for each other.

1. Introduction

According to self-regulated learning theory, learning should ideally take place as cyclical interplay between cognitive and metacognitive processes. This assumption is based on the notion that cognitive and metacognitive processes serve complementary functions (e.g., Boekaerts, 1997; Nelson & Narens, 1994; Nückles, Hübner, & Renkl, 2009). Cognitive processes such as organizing or elaborating directly support knowledge construction (e.g., Chi, 2009; Mayer, 2009; Weinstein & Mayer, 1986), whereas metacognitive processes such as comprehension monitoring and planning of remediation serve the function of regulating the knowledge construction process (e.g., De Bruin & Van Gog, 2012; Nelson & Narens, 1994; Schraw, 1998).

However, this functional complementation may not be the only *active ingredient* that explains why the interplay between these two levels of processing leads to successful learning; it might also be the case that cognitive and metacognitive processes set the stage for each other. Cognitive processes such as organizing and elaborating on learning content might help learners recognize what they do and do not know and thus enhance the concreteness of subsequent comprehension monitoring and remediation planning. If such is the case, then the execution of these cognitive processes might foster the quality of subsequently executed metacognitive processes. Conversely, comprehension monitoring and remediation planning might foster the quality of subsequent cognitive processes. Admittedly, this assumption does not apply to cognitive processes that are executed to remedy previously detected comprehension difficulties (i.e., *remedial cognitive processes*) because they cannot be put into effect unless they are preceded by comprehension monitoring and remediation planning. However, although they do not require previous metacognitive processes, non-remedial cognitive processes that are executed for the purpose of further deepening one's understanding might indirectly benefit from previously executed metacognitive processes as well. If metacognitive processes result in the successful remediation of comprehension difficulties (via remedial cognitive processes), subsequent cognitive processes can start from an enhanced knowledge base. As a consequence, the quality of cognitive processing (e.g., the coherence of organization or the depth of elaboration processes) might increase.

In the present experiments, we aimed at investigating these potential *stage-setting effects* between cognitive and metacognitive processes by manipulating the sequence in which the participants engaged in them. More specifically, after attending a lecture (Exp. 1) or regular school lessons (Exp. 2) the learners had to write learning protocols as follow-up activity. In these learning protocols, the learners were prompted to either (a) engage in the cognitive processes of organization and elaboration prior to engaging in metacognitive processes (i.e., comprehension monitoring and

* Corresponding author.
E-mail address: julian.roelle@uni-bielefeld.de (J. Roelle).

http://dx.doi.org/10.1016/j.learninstruc.2016.11.009
0959-4752/

remediation planning) and implementing their remediation plans or (b) engage in the same metacognitive and remedial processes prior to organizing and elaborating on the learning content. It is important to note that the outlined predictions regarding the stage-setting effects are not specific for the task of writing learning protocols. Hence, other tasks that engage learners in cognitive and metacognitive processing could be employed for examining the targeted effects as well. Our decision to have the learners write learning protocols was mainly based on the fact that written learning protocols have been shown to serve as a beneficial medium for engaging in the targeted cognitive and metacognitive processing (e.g., Berthold, Nückles, & Renkl, 2007; Nückles et al., 2009; see also McCrindle & Christensen, 1995).

1.1. Cognitive and metacognitive processes

Theories of self-regulated learning argue that learners should engage in both cognitive and metacognitive processes (e.g., Boekaerts, 1997; Nelson & Narens, 1994; Nückles et al., 2009; Winne, 1995; Zimmerman, 2008). These processes differ in terms of both their object and function.

Cognitive processes take the learning content as their object. Prototypical instances thereof are *organization* and *elaboration* processes. Organization processes include identifying, structuring, or highlighting the main learning content. Elaboration processes entail that learners generate examples that go beyond newly provided information, link new content to prior knowledge, or critically discuss learning content (e.g., Glogger, Schwonke, Holzäpfel, Nückles, & Renkl, 2012; Weinstein & Mayer, 1986). The main function of cognitive processes is constructing knowledge. For instance, via organization processes learners construct coherent mental representations of newly encountered content in which relevant pieces of information are related to each other; via elaboration processes these mental representations are integrated with existing prior knowledge (e.g., Chi, 2009; Mayer, 2009).

In contrast to cognitive processes, which focus on learning content, metacognitive processes deal with the knowledge construction process. They relate to the current state of the knowledge structures of the to-be-learned content, the goal state, and the available means to change the state (e.g., De Bruin & Van Gog, 2012; Nelson & Narens, 1994). Prototypical examples of metacognitive processes are *comprehension monitoring* and *remediation planning*. Comprehension monitoring serves the function of detecting knowledge gaps or faulty knowledge; thus, it helps learners to avoid detrimental illusions of understanding (e.g., Chi, Bassok, Lewis, Reimann, & Glaser, 1989; Dunlosky & Rawson, 2012). When learners encounter comprehension difficulties, they can engage in remediation planning in a subsequent step; this process includes that learners plan processes in order to remedy any comprehension difficulties they identify (e.g., Glogger et al., 2012; Nückles et al., 2009). Jointly, these metacognitive processes enable learners to *regulate* their knowledge construction (i.e., learning) process (e.g., Schraw, 1998). Note that although it forms a functional unit with previous comprehension monitoring and remediation planning, implementing the respective planned remediation *is not* considered a metacognitive process. Remediation that is put into effect requires processes that directly relate to the respective (not yet well-comprehended) content; hence, implemented remedial processes are considered cognitive in nature (e.g., Nelson & Narens, 1994; Nückles et al., 2009).

The outlined complementary functions of cognitive and metacognitive processes are often used as the main argument to substantiate the notion that learners should ideally engage in both types of processes (e.g., Nelson & Narens, 1994; Nückles et al., 2009; see also; Boekaerts, 1997). The findings of studies that manipulated whether learners engaged in cognitive, metacognitive, or both types of processes seem to support this line of argumentation. For instance, research on learning protocols that are written as follow-up to course work has shown that learners benefit from writing learning protocols even if they mainly engage in the cognitive processes of organization and elaboration while writing them (Berthold et al., 2007); however, the greatest benefit was attained when learners also engaged in the metacognitive processes of comprehension monitoring and remediation planning and implemented their remediation plans (Nückles et al., 2009; see also; Glogger et al., 2012). However, it is questionable whether the benefit of engaging in these processes is solely driven by the outlined functional complementation between cognitive and metacognitive processes; the benefit could also partly arise from the fact that executing the one type of process leads learners to subsequently execute the other type more effectively. In other words, cognitive and metacognitive processes might set the stage for each other.

1.2. Why cognitive and metacognitive processes might set the stage for each other

In their model of the interrelationship between cognitive and metacognitive processes, Nelson and Narens (1994) propose that cognitive processes[1] not only contribute to knowledge construction directly, but also inform metacognitive processes. This theoretical notion is supported by research that deals with the cues that learners utilize to monitor their comprehension. This research indicates that learners frequently base their comprehension monitoring on cues that become accessible from their prior cognitive processing of the respective learning content (e.g., Griffin, Wiley, & Thiede, 2008; Redford, Thiede, Wiley, & Griffin, 2012; Thiede, Griffin, Wiley, & Anderson, 2010; see also; Koriat, 2012; Koriat, Ackermann, Adiv, Lockl, & Schneider, 2014). Furthermore, at least if the cues become accessible from the execution of deep-oriented cognitive processes such as organizing and elaborating on provided information, the findings of previous studies clearly indicate that these cues foster learners' ability to *accurately* judge their level of comprehension (e.g., Griffin et al., 2008; Thiede et al., 2010). Based on these findings, it is reasonable to assume that learners who have already organized and elaborated on specific learning content should be able to monitor their comprehension more accurately and plan remedial processes more concretely than learners who engage in these metacognitive processes without having engaged in these cognitive processes beforehand. Thus, learners should benefit from prior engagement in organization and elaboration in the form of higher quality engagement in metacognitive processing.

Although Nelson and Narens' model provides insights into the quality of metacognitive processing, it does not yield a straightforward prediction regarding the *quantity* of metacognitive processes involved. On the one hand, it can be argued that engaging in metacognitive processes without any previous engagement in the cognitive processes of organization and elaboration should result in more instances of monitoring and planned remediation. Due to the lack of prior (deep-oriented) cognitive processing of the new content, learners might feel that they have not yet reached a sufficiently deep understanding of the content and thus engage in numerous episodes of monitoring and remediation planning. On the other hand, it can be argued that engaging in metacognitive

[1] In their model, the authors refer to cognitive processes as *object-level processes*. However, as this term is rarely used in educational psychology, we use the more common term *cognitive processes*.

Please cite this article in press as: Roelle, J., et al., Do cognitive and metacognitive processes set the stage for each other?, *Learning and Instruction* (2016), http://dx.doi.org/10.1016/j.learninstruc.2016.11.009