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Empirical study

Does visualization affect monitoring accuracy, restudy choice, and comprehension scores of students in primary education?

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ABSTRACT

In the present study, we investigated how 116 fourth and fifth grade students' monitoring skills were associated with restudy choices and explored whether drawing was a useful intervention to improve monitoring accuracy, restudy choice, and comprehension scores. During the first session, all students read a text, judged their learning of the information within that text, selected paragraphs to reread, reread those parts, and then made another judgment of learning (JOL) before doing a post-test. Several significant correlations were found between the various variables involved, such as higher JOLs before rereading related to fewer paragraphs being reread, and JOL-accuracy after rereading was positively correlated with the scores on the postreading questions. For the second session, students were split-up into three conditions: a control condition and two drawing conditions. In the long-drawing condition, students were allowed to draw throughout the whole second session, including post-test. In the brief-drawing condition participants only got to draw the first time they read the second text. We did not find significant differences on the postreading scores. The only differences we found were that the participants in the long drawing group were more accurate in their JOLs before rereading and selected more paragraphs to reread than the other two groups, and invested more mental effort in comparison to the other groups. Drawing more elements was positively correlated with the posttest scores and JOLs, whereas drawing more details was negatively correlated with posttest scores and did not correlate with JOLs. As students in the long drawing condition drew both more elements but also created more detail in those drawings compared to the short drawing condition, it is possible that the beneficial effects of creating drawings were cancelled out by the negative effects.

1. Introduction

Much of what students in primary education have to learn, is presented in written form and the ability for students to comprehend what they read is paramount to their academic development (Law, Chan, & Sachs, 2008; Savolainen, Ahonen, Aro, Tolvanen, & Holopainen, 2008; Spörer; Brunstein, & Kieschke, 2009). Due to a shift from teacher-centered to student-centered education, students have been increasingly required to appropriately monitor and control their reading (Cromley & Azevedo, 2007; Pressley & Wharton-McDonald, 1997; Schraw, 1998). Being capable of regulating one's own learning has therefore become an essential skill in education (e.g., Zimmerman, 1990). However, many students struggle with properly comprehending a text (Cromley & Azevedo, 2007; Garner & Taylor, 1982; Markman, 1977), particularly because they experience difficulties with effectively monitoring and controlling their reading process (Thiede, Anderson, & Therriault, 2003). The present study investigates how students' monitoring skills are associated with restudy choices and explores whether drawing is a useful intervention to improve comprehension monitoring accuracy, restudy choice, and postreading comprehension scores.

1.1. Text comprehension

According to Kintsch's (1986, 1998) seminal work on text comprehension, a text can be conceptually processed at three levels of analysis. First, there is the processing at the very surface level, dealing with the parsing of a text. Within the second level, readers deal with the text-base, where propositions and relations within the text are derived to represent the meaning of the text. The final level is where a situational model is created, or adjusted, and

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involves the construction of a coherent mental representation of what the text is about by integrating text content with previously read information and/or with the reader's prior knowledge. In other words, at the situational level the mental representation of a text is not built up out of the literal words the reader processes, but is a non-verbal representation that is integrated with the prior knowledge of the reader. As such, reading does not only lead to the construction of new propositions for each text, but prior knowledge influences how these propositions are understood. Furthermore, new propositions activate existing schemata, which may in turn activate other propositions as well.

This implies that understanding a text requires students to make inferences. For propositions that have to be understood within the text base and/or situational level, these inferences are coherence inferences, as they deal with the coherence of propositions in the text and other propositions of that same text. For propositions that relate to prior knowledge (and propositions from other texts), these so-called elaborative inferences rely on extension of the text-base by using prior knowledge (Cain & Oakhill, 1990; Oakhill, 1982, 1984). Deficiencies in making inferences, will negatively affect text comprehension (Cain, Oakhill, Barnes, & Bryant, 2001). Importantly, unless activation of context irrelevant aspects are detected, propositions from the text and existing schemata are strengthened and the new propositions are integrated into the existing, now incorrect, schemata. The "unless" in the prior sentence is quite important; readers need to detect irregularities or conflicts in their understanding to improve comprehension. For many students in primary education, this monitoring for understanding is not an automatic process, but rather requires deliberate effort.

1.2. Self-regulated learning and monitoring accuracy

Self-regulated learning is an active, constructive process in which learners plan, monitor, and control their own learning process (e.g., Pintrich, 2000; Winne, 2001; Winne & Hadwin, 1998; Zimmerman & Schunk, 2001). Different elements stand out in this definition. First of all, students are actively involved and are to be engaged in learning. This component links directly to the second element which is the purposeful focus on the achievement of a goal. Students can achieve their goals through the regulation and control of cognition, referring to the use of learning strategies to enhance one's learning (Alexander, Graham, & Harris, 1998; Zimmerman, 1990). According to Alexander et al. (1998), a learning strategy is particularly relevant because it provides procedural knowledge to complete a task: the 'how to' knowledge. Consistent with this, learning strategies have been shown to facilitate self-regulated learning (Dignath, Buettner, & Lanfeldt, 2008) and enhance performance (Donker, De Boer, Kostons, Dignath van Ewijk, & Van der Werf, 2014); in other words, they are essential for academic development. Such strategic top-down activities are particularly necessary if the normal flow of information processing breaks down (Kintsch, 2005).

In order to deploy reading strategies effectively, students need to recognize when they need (and when they do not need) such strategies to enhance comprehension. Therefore, a critical step in the self-regulatory process is monitoring one's progress as not only the comprehension at the end of the reading task is important, but also the process by which it was obtained (see e.g., Segers, Dochy, & Cascallar, 2003). Accurate monitoring helps students to identify which information is well-learned and which information requires additional study. By monitoring one's own comprehension while working on a task, a student evaluates the mental representation of the reading process and his/her progress, which in the model by Kintsch (1998) translates to evaluations of the integrity of the propositional network and/or one's constructed situational model. Whereas research on comprehension monitoring has identified different ways to determine monitoring accuracy (see Bjork, Dunlosky, & Kornell, 2013; Dunlosky & Lipko, 2007) for the purposes of our study we will focus on absolute monitoring accuracy. Absolute accuracy refers to judgments students make with regards to their actual performance, usually represented in terms of over- or underestimations of performance (Dunlosky & Rawson, 2012). These are the kinds of judgments related to assessing one's own performance on a comprehension or learning task, for example to determine a next learning task (i.e., Kostons, Van Gog, & Paas, 2012). In line with this, in the present study we are interested in how students judge their comprehension and contrast this with their actual performance on a reading assignment.

Over the years, research has shown that accurate monitoring seems to be fairly difficult for students. For example, typical intra-individual correlations between peoples' predictive Judgments of Learning (JOL; Koriat & Bjork, 2005) from text and their actual text comprehension performance (i.e., absolute monitoring accuracy) are below 0.30 (Dunlosky & Lipko, 2007; Thiede, Griffin, Wiley, & Redford, 2009). One reason for inaccurate monitoring may be that both reading and monitoring one's comprehension of that performance simultaneously compete for limited working memory resources; especially under conditions of high cognitive load, monitoring or reading may be negatively affected by a lack of cognitive resources (Van Gog, Kester, & Paas, 2011). Furthermore, research has investigated several factors that influence the accuracy of JOLs (Dunlosky & Nelson, 1992; Nelson & Dunlosky, 1991; Nelson, Narens, & Dunlosky, 2004) and subsequent selection for restudy (Metcalfe & Kornell, 2005; Thiede & Dunlosky, 1999; Van Loon, de Bruin, Van Gog, & Van Merrienboer, 2013). According to the cue-utilization model (Koriat, 1997), readers have access to many cues that they can use to make a judgment of learning when reading a text. In particular, there is evidence that if readers base their judgments on representation-based cues, which are cues that stem from trying to enhance the situation model while reading, these readers have higher monitoring accuracy (Thiede, Griffin, Wiley, & Anderson, 2010). Critically, however, Thiede et al. (2009) have shown that students often do not use such representation-based cues, because using these cues requires a considerable amount of effort. Moreover, it seems that cognitive biases can guide readers to the utilization of the wrong cues to assess their performance. For example, when people fail to solve a problem, and are subsequently provided with feedback on the correct solution, they are often inclined to overestimate the likelihood that they could have produced it themselves (i.e., hindsight bias), and when an answer comes to mind easily, it is not only more likely to be provided, but also more likely to be assumed correct (i.e., availability bias; for a review, see Bjork, 1999). Based on the above analysis, it seems that students need some support to make accurate judgments of their level of text comprehension.

1.3. Improving JOL in text comprehension

Several studies focusing on improving the accuracy of monitoring judgments have examined different manipulations that increase the accessibility of cues related to the situation model of a text (for an overview, see Thiede et al., 2009). Thiede et al. (2003), for example, showed that when more accurate judgments of text comprehension were induced, people restudied more strategically and performed better. Specifically, their results showed that summarizing or providing keywords after reading, but prior to judging comprehension, was an effective way to improve college students' judgments of text comprehension. Summaries or keywords generated after a short delay were more effective at improving JOLs than those made immediately after reading.