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The impact of text coherence on learning by self-explanation

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Abstract

Previous research has shown that encouraging learners to explain material to themselves as they study can increase their understanding. Furthermore, different types of material (e.g. text or diagrams) influence learners' self-explanation behaviour. This study explores whether the coherence of text impacts upon the self-explanation effect. Forty-eight low-knowledge learners (university students) learnt about the circulatory system with text that was designed to be either maximally or minimally coherent. Half of these learners also received self-explanation training. Results showed that learners given maximally coherent text learnt more, as did learners who self-explained. However, this was not because coherent text increased self-explaining. Instead minimally coherent text significantly increased the number of self-explanations that learners made. It is suggested that self-explaining in the minimal text condition served to compensate for weaknesses and gaps in the text, whereas self-explaining in the maximal text condition may have led learners to detect flaws in their mental models and repair them. Consequently, rather than providing a minimally coherent text which compels low knowledge learners to self-explain to overcome its deficits, we should instead encourage learners to self-explain from well structured and explicit text.
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1. Introduction

Not all learning from text is successful. In fact, a body of research in a variety of areas has shown that in order for learners to elicit the highest gains from studying, they should actively construct their understanding as they read. This active processing of text may be encouraged by a variety of strategies – for example, students could take notes, draw diagrams of what they read, answer questions posed by others or generated by themselves. One strategy that has been studied extensively in recent years is that of self-explaining. A self-explanation is knowledge generated by learners that states something beyond the information they are given. Extensive research has shown that students develop a deeper understanding of material they read if they self-explain. Texts themselves can be written in ways that either promote or inhibit active processing. A number of studies reviewed below have found that texts on the same topic manipulated in seemingly subtle ways can have dramatic impacts upon learning. The current study was designed to explore the relationship between the self-explanation strategy and the specific features of the text, and how this impacted on both what and how students learnt.

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1.1. The impact of self-explaining on learning

Much research has acknowledged that active construction of understanding during learning is important. One learning strategy that encourages learners to do this is self-explanation. A self-explanation (shorthand for self-explanation inference) is additional knowledge generated by learners that states something beyond the information they are given to study. For example, in the material used in this study, we might tell learners "*The heart is the muscular organ that pumps blood through the body*", and would code a self-explanation if the learner responded "*so it's got to be a muscle that is strong enough to pump blood around the whole body*".

A substantial number of studies have reported that students develop a deeper understanding of material they have studied if they generate explanations to themselves whilst learning (Aleven & Koedinger, 2002; Bielaczyc, Pirolli, & Brown, 1995; Chi, Bassok, Lewis, Reimann, & Glaser, 1989; Chi, deLeeuw, Chiu, & Lavancher, 1994; Chi, Siler, Jeong, Yamauchi, & Hausmann, 2001; Cote, Goldman, & Saul, 1998; Renkl, 1997, 2002; Wolfe & Goldman, 2005). In the original study, Chi et al. (1989) gave college students learning mechanics three problem examples containing text and diagrams to study. Students' performance on end of chapter exercises and isomorphic problems were then measured. They found students who spontaneously generated a large number of self-explanations (SEs) during learning scored over twice as highly on the post-test as those who gave few explanations. High SE students also demonstrated better monitoring of their own understanding whilst learning. In a follow-up study, Chi et al. (1994) asked high school students to read a biology text. Half were prompted to self-explain and half read the text twice. The group that self-explained learned significantly more (26%) than the reading only group (16%). Subsequently, a number of studies have confirmed this effect and examined the scope of its application.

It is evident that these effects are observed in a wide variety of domains (e.g. physics problem solving (Chi et al., 1989; Conati & VanLehn, 2000) probability (Renkl, 1997); cardio-vascular system (Chi et al., 1994, 2001), geometry (Aleven & Koedinger, 2002), history (Wolfe & Goldman, 2005), and Lisp programming (Bielaczyc et al., 1995)). Therefore, we know the beneficial effects of self-explanations can be found for both procedural and conceptual domains, can promote analogical transfer (Neuman & Schwarz, 1998) and are not limited to learning from examples.

The benefits of self-explaining are not only present when students spontaneously generate explanations. Students who are prompted to give self-explanations also profit from this strategy (Chi et al., 1994). Nor are the results due to the fact that students who know more to begin with self-explain more. Studies such as Chi et al. (1994) and Ainsworth and Loizou (2003) have found no relationship between the degree of self-explaining and prior knowledge. Although studying whilst self-explaining takes longer than studying without self-explanation, the results are not simply due to time on task. Renkl (1997) required learners to study worked out examples of probability problems for 25 min. Those learners who self-explained more (especially those who anticipated solution steps or referred to principles) learnt more, even when time was controlled.

A number of studies have compared self-explaining to other learning strategies, the simplest being to reread the material (as in Chi et al., 1994). As measuring self-explanation often requires learners to speak out loud, studies have contrasted self-explanation to simple prompts to speak out loud. Walthen (1997, quoted in Chi, 2000) found that self-explanation was a more effective strategy than giving standard verbal protocols as did McNamara (2004) who compared self-explanation to reading out loud. O'Reilly, Symons, and MacLatchy-Gaudet (1998) compared the performance of three groups learning about the cardio-vascular system – one who repeated sentences out loud, one who engaged in elaborative interrogation (answering questions such as "why does it make sense that …") and one who were given typical self-explanation prompts. The self-explanation group had significantly better cued recall and recognition than either of the other two groups.

Self-explanation can help learners actively construct understanding in two ways; it can help learners generate appropriate inferences and it can support their knowledge revision (Chi, 2000). If a text is in someway incomplete (and most are – see below) then learners generate inferences to compensate for the inadequacy of the text and to fill gaps in the mental models they are generating. Readers can fill gaps by integrating information across sentences, by relating new knowledge to prior knowledge or by focusing on the meaning of words. Self-explaining can also help in the process of knowledge revision by providing a mechanism by which learners can compare their imperfect mental models to those being presented in the text. They are then in a position to detect conflicts between their beliefs and the appropriate ones, and so begin to revise their mental model.

Whilst no one would argue that self-explanation is the only knowledge building strategy, this evidence suggests that it is an effective one and a strategy worth encouraging students to utilise. Consequently, studies have examined if

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