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From text to graphical summary: A product- and process oriented assessment to explore the development in fifth and sixth graders' dynamic construction

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ABSTRACT

Working with graphical summaries is promising to assist students' text-based learning and to provide teachers with an assessment method for students' text processing skills. This study investigates students' development in graphical summary products and ongoing summarization processes during a ten-week instructional intervention. Further, an in-depth exploration of students' graphical summary construction is provided. Two experimental conditions (working with either researcher-provided or student-generated mind maps) and one control condition were compared, involving 18 fifth and sixth graders. Data were analyzed from a product- and process-oriented perspective. Results indicate that experimental condition students make qualitatively better graphical summaries than control condition students after the intervention. Little development was found in time spent on pre-writing (i.e., planning their graphical summary) and post-writing (i.e., revising their graphical summary), indicating students' lack of metacognitive processes guiding their summary construction. The in-depth exploration of students' construction phase revealed three less effective and two more effective elaboration approaches. These results can inform the future design of strategy instructions incorporating graphical summaries and teachers' assessment practices.

1. Introduction

In the current information society, education is expected to prepare students for text-based learning (i.e., to process and acquire knowledge from texts) as they are increasingly overwhelmed with to-be-learnt informational texts throughout their educational career. In this respect, the importance of self-regulated learning is stressed in educational standards and considered as a key competence in the twenty-first century (Hoskins & Crick, 2010). Self-regulated learners act in a planned and cyclical way to regulate their thoughts, feelings, and actions to meet personal goals (Boekaerts, Pintrich, & Zeidner, 2000). Applied to text-based learning, students have to be inducted in independently applying a broad repertoire of text-learning strategies to process and learn informative texts (Merchie & Van Keer, 2014; Merchie, Van Keer, & Vandevelde, 2014; OECD, 2010). Within this text-learning strategy repertoire, summarization strategies become of major importance at the end of elementary education. From then on, the focus shifts from learning to read and write towards reading and writing to learn to obtain instructional knowledge from texts (Newell, 2006).

Writing a summary is regarded as a powerful strategy helping students to process informative texts and to reduce them to their essence (Broer, Aarnoutse, Kieviet, & Van Leeuwe, 2002; Friend, 2001). It is believed that summarizing texts leads to deep and higher-level text processing, as it prompts essential cognitive strategies (i.e., elaboration, paraphrasing, connecting information to prior knowledge; and organization, such as text reorganization) and metacognitive strategies (e.g., metacomprehension accuracy) (Anderson & Thiede, 2008; Bangert-Drowns, Hurley, & Wilkinson, 2004; Weinstein, Jung, & Acee, 2011; Weinstein & Mayer, 1986). Although a summary can take many forms (e.g., linear outline, matrices, or maps), summaries requiring graphical text reorganization are found to be especially beneficial in students' text processing and learning (Dansereau & Simpson, 2009; Nesbit & Adesope, 2006). These 'graphical summaries' are defined in this study as visually coherent and hierarchically organized spatial structures of linear multi-paragraph text. Rather than surface-level or linear learning strategies (e.g., rereading or literally memorizing text), deep-level strategies such as graphical summarization evoke the general capacity to analyze, structure, and organize knowledge which promotes deep text processing (Lahtinen, Lonka, & Lindblom-Ylänne, 1997; Nesbit & Adesope, 2006; Ponce & Mayer, 2014).

Despite the importance of graphical text summarization, many—especially young—students still turn to the more counterproductive

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copy-and-delete summarization method. That is, they sequentially read the text and decide for each element on inclusion or deletion. If the element is included, they more or less copy the text verbatim and do not paraphrase or reorganize text (Brown & Day, 1983; Friend, 2001). These students not only encounter difficulties with the more cognitive strategies during summarization (e.g., organization and elaboration), but also experience great difficulty with more metacognitive higher-order thinking processes such as planning and revising their work (McCutchen, 2006). In this way, their summarization is rather a simple text selection process instead of a text synthesis process, whereby ineffective strategies are employed during reading (e.g., irrelevant information is regarded as main idea information) and writing (i.e., trivial information is included in the summary). Previous studies point at the fact that students will not develop these strategies spontaneously, and explicit inducement is required by means of instructional interventions (Alexander, 1998; Mayer, 1996; Pressley, Borkowski, & Schneider, 1987; Weinstein et al., 2011). Explicit instruction in graphical summarization strategies thus seems necessary, as these students lack the essential cognitive and metacognitive processes to create a graphical summary and will not develop these processes spontaneously (Garner, 1990; Friend, 2001; Mateos, Martin, Villalon, & Luna, 2008).

1.1. Instruction in graphical summarization strategies

A first important step in developing an instruction in graphical summarization strategies is identifying a solid, well-founded theoretical base. Based on a literature review on text-learning research in general, summarization strategies in particular, and writing-to-learn research (e.g., Alamargot, Plane, Lambert, & Chesnet, 2010; Berninger, Fuller, & Whitaker, 1996; Flower & Hayes, 1981; Friend, 2001; Schlag & Ploetzner, 2011), essential cognitive levels of processing and mental operations can be identified which are executed during three summarization phases (Table 1). Overall, summarization occurs during the construction of a dual-level cognitive text representation (i.e., a micro-level and macro-level presentation) while passing through the three phases of pre-writing, construction, and post-writing (Alamargot et al., 2010; Berninger et al., 1996; Flower & Hayes, 1981; Friend, 2001). The main goal of the *pre-writing or planning phase* is to build a micro-level text representation to decide which text information should be included in the summary. Here, students focus on the text's surface structure such as text-based signals, structural cues, and explicit markers such as subtitles or figures. During scanning and reading, students' attention is guided towards ‘repeated references’ (Friend, 2001) or ‘argument repetitions’ (van Dijk & Kintsch, 1983); that is, the more an idea is referred to in the text, the more important it is. Students can already structure the to-be-summarized text content by marking or underlining main and sub ideas. In the *construction phase*, students consider the text's macro structure—that is, a terse representation of the most important information. Here students engage in the cognitive process of ‘generalization’ to identify the hierarchical arrangement of text ideas (Friend, 2001). Three summary-specific mental operations are performed: deletion (i.e., leaving out unnecessary, trivial, or off-the-subject information), generalization (i.e., finding blanket terms which pull different ideas together), and construction (i.e., transcribing the main and sub ideas into a coherent structure) (Friend, 2001; van Dijk & Kintsch, 1983). In the final *post-writing or revision phase*, several metacognitive processes are in interplay to critically reread, evaluate, and revise the graphical summary when necessary (McCutchen, 2006). Several revision actions can be undertaken (e.g., verifying the understandability, readability or completeness of the graphical summary). In sum, based on previous theoretical and empirical research, different summarization phases, cognitive levels of processing, and mental operations can be identified during graphically summarizing text. Table 1 shows the correspondence between these different elements.

Given the importance of graphical text reorganization, an accessible spatial format was selected to include in the instruction of graphical summarization strategies. Two important reasons were decisive in the adoption of mind maps (Buzan, 1974; Buzan, 2005) during strategy instruction in the present study. First, mind maps' design and spatial content arrangement lend themselves perfectly to graphical text summarization. Mind maps are typified by specific design-principles (e.g., including thick and thin branches, capitals and small letters, images), which are theoretically and empirically underpinned (e.g., Anderson & Hidde, 1971; Haber, 1970; O'Donnell, Dansereau, & Hall, 2002). These principles are strictly related to the hierarchical text representation. The text's main ideas are written in capital letters on thick branches directly related to the central theme; the text's super- and subordinate ideas are written in small letters on thin sub-branches. Different text relationships can be visualized by adding arrows or connectors (Buzan, 2005). This format is very accessible for elementary school students and differs greatly from the more constrained top-down linear arrangement of concept maps wherein explicit connective terms must be used between concepts (Novak, 2002). A second important reason to include mind maps in strategy instruction is related to important questions regarding their instructional use in classrooms. Although mind maps are already frequently employed in educational practice, there is a lack of evidence-based classroom research, especially in elementary education. Although other visual representations (e.g., concept maps) have been extensively studied in prior research (Nesbit & Adesope, 2006; Novak, 2002), mind maps have received far less empirical attention. Still, in the limited research available, prior research has already indicated that upper elementary students are able to make graphical summaries by means of mind mapping after a researcher-delivered intervention (Merchie & Van Keer, 2013). However, many unanswered questions are left: How precisely should teachers themselves integrate mind maps into strategy instruction? Which concrete guidelines can be formulated to spatially arrange text information in this way? It can be hypothesized that different instructional approaches such as working with either researcher-provided or student-generated maps might influence students' graphical summarization skills (Stull & Mayer, 2007). In this respect, researcher-provided mind maps could serve as scaffolds for students' strategic text processing, showing students how linear text information is transformed through the phases of pre-writing, construction, and post-writing. Because working with these worked-examples reduces the level of cognitive load, more cognitive capacity would be available for important strategic activities (Sweller & Chandler, 1994). On the other hand, students might learn more from immediately conducting all strategic activities by themselves in creating student-generated maps. By their active and immediate engagement, the material is processed in a deeper way and transfer to independent tasks will be facilitated (Stull & Mayer, 2007; Leopold, Sumfleth, & Leutner, 2013). It could be expected that these students will be more able to independently construct a graphical summary and will spent more time on pre-writing, construction, and post-writing, since they received specific and explicit instruction. In this respect, a specific ‘main idea’ elaboration approach (i.e., the way in which a graphical summary is systematically constructed) with mind map construction guidelines is already proposed in the more popular literature to guide students' map construction; that is, defining and drawing all main branches and elaborating on each main branch

Table 1
Theoretical base of (graphical) summarization instruction: correspondence between summarization phases, cognitive levels of processing, and mental operations.

Phases	Cognitive levels of processing	Mental operations
Pre-writing or planning phase	Micro-processing: micro-level representations (local coherence)	Repeated references Argument repetition
Construction phase	Macro-processing: macro-level presentation (global coherence)	Deletion Generalization Construction
Post-writing or revision phase		