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Spontaneous Mind Map use and learning from texts: The role of instruction and student characteristics

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Abstract

Independently processing and learning informative study texts becomes increasingly important from the age of 11-13, when the focus shifts from 'learning to read' to 'reading to learn'. The need arises to support students in dealing with study texts and stimulating generative study strategies promoting active knowledge transformation. This study shows that a Mind Map (MM) intervention can prompt fifth and sixth graders to use MM during text learning. Furthermore, the MM instruction method, students' gender, MM appreciation, and self-efficacy seem to influence their spontaneous use. No significant differences were found on immediate free text recall.

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Keywords: Learning from texts, Mind Maps, instruction method, gender, appreciation, self-efficacy

1. Introduction

1.1 Working with Mind Maps: stimulating active knowledge transformation

Currently, students are continuously challenged by the exponential knowledge increase in our information society and the large amounts of information they have to process and learn independently. This becomes increasingly important from the age of 11-13, when the focus shifts from 'learning how to read' to 'reading to learn' (Bakken & Whedon, 2002; Hall-Kenyon & Black, 2010). From this point on, students are expected to spend more and more time on obtaining new content from their textbooks (Hall-Kenyon & Black, 2010; Schellings & Broekkamp, 2011). Consequently, the establishment of a good study method is crucial to meet this more complex study requirements (Meneghetti, De Beni, & Cornoldi, 2007). In this respect, the need arises from late elementary education on to stimulate the development of specific learning strategies aimed at effectively processing and learning from texts (Perels, Gürthler, & Schmitz, 2005; Pintrich, 2004; Rawson & Dunlosky, 2007).

Previous research indicates that the use of generative study strategies (i.e. strategies evoking active knowledge transformation) rather than non-generative strategies (e.g. repeatedly reading or literally copying texts) are associated with higher performance when studying (e.g. Davies, 2011; Lahtinen, Lonka, & Lindblom-Ylänne, 1997;

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Nesbit & Adesope, 2006; Weinstein & Mayer, 1986). Working with graphic organizers (GO), such as concept maps (Novak, 2002), thinking maps (Hyerle, 1996), and Mind Maps (Buzan, 1974; Buzan, 2005), is such a specific generative strategy transforming linear text into a graphical representation. Graphic organizers are spatial arrangements of words (or word clusters) representing the conceptual organization of a text (Stull & Mayer, 2007). As they clarify the relationships between important concepts in a text and illuminate big ideas (Banikowski, 1999; Crawford & Carnine, 2000), they can help students process, structure and acquire the large amounts of information they are confronted with (Dansereau & Simpson, 2009; Vekiri, 2002). When students are reading, analyzing, or constructing graphic organizers, they are cognitively engaged in searching connections among the concepts and thus deeply processing the learning material. By doing this, they develop a general capacity to structure and organize knowledge, which in turn promotes generative and deep text processing (Nesbit & Adesope, 2006; Schnotz, 2002). Several general theories underpin the use of graphic organizers. The Dual Coding Theory (Paivio, 1991) and the Cognitive Load Theory (Sweller & Chandler, 1994; Sweller, van Merriënboer, & Paas, 1998) point to advantages in the decrease of cognitive load and the recall of text information due to the simplification of the complex relationships and ideas in the text. As there is a growing need of purposive interventions to support children in learning from texts, familiarizing them with graphic organizers during content courses seems an important step towards stimulating active knowledge transformation. Therefore, in this study the possibilities of working with Mind Maps as a specific type of graphic organizer are explored.

Mind Maps (MM) (Buzan, 1974) are already frequently used in educational practice. In a Mind Map, one key concept, often represented as an image, is located at the middle of the page. From this central topic, several related main topics in different colors are radiated out in the shape of thick branches. Attached to these main branches, other smaller branches represent related concepts. In this way, related words are associated through curved main and subbranches. Mind Maps can be further enriched by colors, images, codes, arrows, and dimension to reflect personal interest and individuality (Buzan, 2005). The specific Mind Map characteristics are grounded and supported by research findings from both educational as well as brain research (Anderson & Hidde, 1971; Budd, 2004; Haber, 1970; Mento, Martinelli, & Jones, 1999; Michalko, 2003). Beside these specific characteristics and the theories referred to above several studies indicate that Mind Maps are effective in helping children to structure, summarize, and study subject matter (Brinkmann, 2003; Farrand, Hussain, & Hennessy, 2002). Most of these studies focus however on science subjects in secondary or higher education, although the importance of the acquisition of information processing skills in earlier grades is frequently stressed (Guastello, Beasley, & Sinatra, 2000; Rawson, 2000). Furthermore, in these previous studies only a very restricted period of Mind Map training generally proceeds testing. As goal-oriented interventions can stimulate strategy use from elementary grade on (Dignath & Büttner, 2008; Lee, Lan, Hamman, & Hendricks, 2008), the present study investigates the impact of a long-term Mind Map intervention in elementary education on active knowledge transformation during an independent learning task.

1.2 The role of instruction and student characteristics in spontaneous Mind Map use during learning from text.

There are numerous factors that play a role in the effectiveness of working with Mind Maps in elementary grades. In this respect, the present study explicitly focusses on specific class and student-level variables that might influence students' spontaneous use of Mind Mapping. First, the specific instruction can play a crucial role when working with maps. In research literature, a well-known discussion is going on about working with author-provided versus student-generated maps (Kirschner, Sweller, & Clark, 2006; Lee & Nelson, 2005; Stull & Mayer, 2007). On the one hand it is argued that stimulating students to create Mind Maps themselves permits them to actively engage in selecting and organizing the new subject matter in relation to their existing knowledge structures (McCagg & Dansereau, 1991; Stull & Mayer, 2007). On the other hand, researchers mainly inspired by cognitive load research (Sweller & Chandler, 1994) are convinced that author-provided maps provide more opportunities to learn from a worked-example (Kirschner et al., 2006; Stull & Mayer, 2007). However, very little is known about the extent to which the different instruction approaches elicit the spontaneous use of this technique for text studying. Most students participating in previous studies were tested after being explicitly asked to read or learn a text passage with an author-provided GO or when asked to construct one themselves (Stull & Mayer, 2007). Getting insight into this question can inform educational practice on how to integrate MM effectively into their content courses. In this respect, it can be hypothesized that students taught to work with student-generated MM (SG-students) rather than with author-provided MM (AP-students) will be more inclined to autonomously create MM during independent text studying.

In addition to the instruction approach, various learner characteristics may affect students' spontaneous MM use as well. A first aspect taken into account in the present study are gender differences (Rozendaal, Minnaert, & Boekaerts, 2003; Slotte, Lonka, & Lindblom-Ylänne, 2001). In the research of Slotte et al. (2001) the hypothesis that boys are more inclined to transform linear text into graphic maps due to their higher spatial abilities was countered. As research on gender differences regarding organisational strategy use is not very large and still inconclusive (Rozendaal et al., 2003), this will be specifically included in the study. Secondly, also motivational factors might encourage or discourage students to use the MM technique spontaneously (Goodnough & Woods, 2002; Schnotz, 2002). In this respect, two factors are addressed. A first important prerequisite towards spontaneous use of a certain learning strategy is the student's personal appreciation ascribed to this particular learning strategy after working with it during daily educational practice. Furthermore, also students' self-efficacy regarding Mind Mapping can influence spontaneous use. Based on previous research (Bandura, Barbaranelli, Caprara, & Pastorelli, 1996; Linnenbrink & Pintrich, 2002) and adjusted to this research context, this can be defined as the learners' judgment concerning their task-specific capabilities to create a Mind Map from a text. It is expected that students who create a Mind Map during text learning will report higher on MM appreciation and MM self-efficacy.

In sum, the aim of the present study was to explore a) whether a Mind Map intervention can stimulate fifth and sixth graders to use MM spontaneously during independent text learning, b) to what extent the instruction approach and student characteristics play a role in their spontaneous use of MM, and c) whether there is any difference in free text recall between conditions and between students who did and who did not create a Mind Map during independent text studying.

2. Methods

2.1 Design

A quasi-experimental pre- and posttest design was applied in authentic fifth and sixth-grade classes. The focus lies on time interval (pretest and posttest) and the research condition (two experimental conditions and one control condition). The main goal of both experimental conditions was to stimulate active knowledge transformation of informative texts in a structured way. Therefore, a previously pilot-tested Mind Map training of 10 weeks (Merchie & Van Keer, 2011) was embedded in social study and science courses during regular classroom hours by the regular classroom teachers. The Mind Map training consisted of 10 lessons of 50 minutes. In the first experimental condition working with author-provided MM, active knowledge transformation was stimulated through different types of exercises (e.g. fill in the blank, open questions, searching for answers in the Mind Map) that pupils had to complete on the basis of the informative texts and the accompanied author-provided MM. In the second experimental condition teaching students to self-generate MM, students processed the subject matter in informative texts gradually by constructing Mind Maps themselves. The classes in the control condition received no explicit training in active knowledge transformation of informative texts by means of Mind Maps.

2.2 Participants

This study was carried out with 20 fifth and 22 sixth-grade classes (n=644), respectively 213 students in the author-provided MM condition, 219 in the student-generated MM, condition and 212 in the control condition. Table 1 represents the descriptive information concerning grade and gender across conditions.

		Author-provided Mind Map condition		Student-generated Mind Map condition		Control condition	
		n	%	n	%	п	%
Grade	Fifth-grade	108	50.9	108	49.3	131	61.5
	Sixth-grade	104	49.1	111	50.7	82	38.5
Gender	Male	95	44.8	92	42.0	106	49.8
	Female	117	55.2	127	58.0	107	50.2

Table 1. Overview of the participants across conditions

2.3 Instruments

Students' spontaneous use of Mind Maps while studying text was assessed in a pre- and posttest by a specific learning task administered in class. Students were asked to study an informative text (500 words) for 30 minutes as if they would prepare for a test. The two texts entitled 'The wonderful world of seahorses (pretest) and meerkats (posttest)' consisted of six central topics: general information, body parts, environment, eating habits, reproduction, and special details about the animal. Text readability and difficulty was evaluated by an expert, an elementary school teacher, and an elementary school student. While studying, students were free to use scratch paper and were not prompted to make a Mind Map in order to assure that the strategy was used spontaneously (Veenman, 2011). The scratch papers were collected afterwards to code with a 0 or 1 according to whether or not a Mind Map was constructed during text learning.

After handing in their learning materials, text acquisition was tested with a free recall test. Students were asked to write everything down they still remembered from the text. The recall score represents the percentage of recalled text information.

After completing the recall test, students in the experimental conditions completed a questionnaire concerning students' MM appreciation and MM self-efficacy. The questionnaire consists of 9 items on a 5-point Likert scale and contains 2 subscales: MM appreciation (5 items, α =.86, e.g. 'Mind Maps help me to understand and learn an informative text') and MM self-efficacy (4 items, α =.71, e.g. 'I am good in making a Mind Map').

2.4 Data analysis

Chi-square analyses were used in order to compare the spontaneous MM use during text studying across conditions and gender. Further, Independent Sample t-tests were used to verify differences between MM appreciation and MM self-efficacy in the experimental conditions, between boys and girls and between pupils who did and did not construct a MM during text learning. A repeated measures analysis of variance was applied to analyse text recall differences between the three conditions.

3. Results and discussion

Results from the chi-square analysis show no differences in spontaneous MM use across the conditions at pretest $(\chi^2=5.17, p=.076)$. Only a few students spontaneously construct Mind Maps during informative text learning before the onset of the intervention. When looking at the posttest results however, a significant relationship between spontaneous Mind Map use and condition is shown $(\chi^2=74.65, p=.000)$. In the control condition only 11.7% of the students created a Mind Map during text studying, compared to 32,1% in the student-generated condition (SG-students), and 51,5% in the author-provided MM condition (AP-students) (Figure 1). These results lend to support that an intervention whereby informative texts are processed by means of MM during regular class hours can prompt students to spontaneously transform their linear texts into graphical representations during independent text learning. Against expectations, more students in the author-provided MM condition spontaneously constructed a MM than students who gradually learned to make Mind Maps themselves. This finding is somewhat surprising, as SG-students got more explicit guidelines and practice in the construction of Mind Maps during the intervention period. A tentative explanation for this finding could be that SG-students were less inclined to create a MM since they could make more accurate estimations of the time it cost to Mind Map the text. This was confirmed by a student in an informal interview after the test: '*I knew there was only limited time for studying the text so by the time I would have finished my MM, no time would be left to review and study it'.* This student however did not realize that by actively



Figure 1. Percentage of students spontaneously making a Mind Map during pre- and posttest.

When narrowing the focus down to the gender of the MM users in the posttest, the analysis show significant relations between gender and spontaneous MM use in both the author-provided (χ^2 =13.91, *p*=.000) and student-generated MM condition (χ^2 =14.47, *p*=.000). With respectively 62% (AP) and 70% (SG) female Mind Mappers, it were predominantly girls who drew a Mind Map while studying text. In corroboration with the research of Slotte et al. (2001), the hypothesis that boys intend more to transform linear text into graphic maps was not supported. Future studies should unravel why girls seem more inclined to create Mind Maps. Are they more attracted by the technique due to the specific MM characteristics (e.g. use of colors, figures)? Is there any link with gender differences in creativity or spatial ability?

To verify differences in MM appreciation and MM self-efficacy between conditions and gender, first general scores across the two MM conditions were compared. Results of the independent sample t-test show significant differences as students in the author-provided condition overall report higher scores on both MM appreciation (t(412) = 6.24, p=.000) and MM self-efficacy (t(414) = 6.68, p=.000). In this respect, AP-students do not only appreciate the technique more and are more intended to use it in the future, they also judge themselves as more competent in creating Mind Maps. Again, this is a remarkable finding since they processed texts with worked-examples and were not taught the technique explicitly. On the other hand, this can explain the finding that students from the AP-condition made more use of the MM technique for text studying. When focusing on students who did or did not spontaneously created a Mind Map during the posttest, the MM users do appreciate using MM more (t(409) = -6.42, p=.000) and judge themselves as more competent in creating MM (t(411) = -4.13, p=.000). This result was in line with expectations, as positively motivated beliefs are associated with higher strategy use (Winne, 2010). With regard to gender differences it was found that predominantly girls drew a MM. In line with this result, girls do appreciate the technique more in both MM conditions (t(411) = -3.24, p=.001). There were however no gender differences concerning students' MM self-efficacy (t(413) = -0.34, p=.736).

Finally, as previous research indicated that the use of generative study strategies, such as Mind Mapping, is associated with higher performance (e.g. Lahtinen et al., 1997), effects on students' free text recall were studied. No significant differences were found, however, between the conditions (F(582,2)=1.94, p=0.144) and between students who did or did not drew a Mind Map (F(577,1)=.002, p=0.968). This result might be due to the fact that the

strategy was of no direct help for immediate global text recall. Another explanation might be that students were tested immediately after learning and no delayed recall test was administered (Stull & Mayer, 2007). Furthermore, because of the relatively short time span wherein students had to study the text, it is also possible that MM users did not gain advantage of their strategy to study the text by Mind mapping. This presumption is based on the finding that the majority of the MM on the scratch papers were unfinished. In addition to administering a delayed recall test and providing more study time, another recommendation for future research is the inclusion of a recall test consisting of different question types (e.g. text-based questions, inference questions) (McNamara & Kintsch, 1996) to gain insight in the specific relationship between Mind Mapping and text recall. It must also be noted that the present explorative study focused on one specific direct observable overt study strategy (i.e. using Mind Maps). Therefore, future studies should also take into account covert study strategies, such as mentally associating or combining ideas without writing them down (Kardash & Amlund, 1991) and their effect on learning from text with or without Mind Maps.

In conclusion, the results of the present study support the idea that working with Mind Maps during daily educational practice can stimulate fifth and sixth graders to actively transform linear text by means of MM. This can be seen as a step towards encouraging the use of more generative study strategies in elementary school. Students who spontaneously drew Mind Maps during learning from texts were predominantly girls and mainly students working with author-provided Mind Maps during the intervention period. These groups also appreciated the technique more. This study represents a start in investigating the use of Mind Maps in elementary grades, hoping to inspire other educational researchers to replicate, confirm, or broaden our findings based on the suggestions for future research.

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