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Retrieval-based learning: The need for guided retrieval in elementary school children

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ABSTRACT

Three experiments were aimed at adapting retrieval practice techniques that are effective with college students to work with elementary school children. Children participated in their classrooms and completed activities with educational texts selected from the school curriculum. In Experiment 1, when children were asked to freely recall the texts, they recalled very little of the material (about 10%) and showed almost no improvement after rereading. In another condition that involved creating concept maps, the children produced only about 20% of the ideas on their maps, even though they viewed the texts during the entire activity. Experiments 2 and 3 explored ways to provide support during retrieval activities. In Experiment 2, children were very successful at retrieving knowledge on concept maps that were partially completed. In Experiment 3, a question map activity, where questions were displayed in a relational map format, was effective for guiding retrieval practice and improving learning relative to repeated studying. The results demonstrate the importance of examining strategies that work with college students with young children in educational settings using authentic materials. The results also highlight the need for guided retrieval practice in young children.

1. Introduction

Retrieval practice is a powerful way to improve learning. The general idea, which we refer to as *retrieval-based learning*, does not have to be complicated to implement. Essentially, retrieval practice simply involves having learners set aside the material they are learning and practice actively reconstructing it on their own. When students are capable of successfully retrieving knowledge, and when they practice doing it repeatedly, retrieval practice will promote learning that is robust, durable, and transferable to new contexts (Carpenter, 2012; Karpicke, 2012). Retrieval practice could be incorporated into a variety of existing educational activities. That is, many activities could be converted into retrieval-based learning activities simply by having students complete them in the absence of the to-be-learned material, so students are required to remember what they experienced in previous study episodes.

Because retrieval-based learning can be done in a variety of ways, a general challenge is to develop and test new ways to implement retrieval practice in educational settings. There are several criteria that are necessary to accomplish this translation from laboratory work to classrooms. Namely, research on learning strategies like retrieval practice needs to be conducted with actual educational materials selected directly from school curricula. In addition, learning activities need to be designed so that they could be implemented in classroom settings. Therefore, it follows that experimental work on such learning activities should be conducted in actual classrooms.

Perhaps most importantly, retrieval-based learning tasks need to be scaled to work with younger children. The vast majority of research on retrieval practice has been carried out with college students, and very little has been done to examine retrieval practice effects in children, specifically those in the late elementary grades (see Blunt & Karpicke, 2014b; Dunlosky, Rawson, Marsh, Nathan, & Willingham, 2013). Grades 3–5 represent a critical time in children's educational development, because by these grade levels children have learned to read, and they are now increasingly "reading to learn." That is, late elementary school children are beginning to read material and implement strategies on their own in order to learn from what they are reading. Thus it is essential to examine retrieval practice in elementary school children.

Some recent work has focused on applying retrieval practice to learning in young children. That research has confirmed that children do exhibit retrieval practice effects in simple word-pair experiments (Blunt & Karpicke, 2014b), can learn educationally relevant

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facts from multiple-choice tests (Marsh, Fazio, & Goswick, 2012), and benefit from retrieval practice of vocabulary words (Goossens, Camp, Verkoeijen, & Tabbers, 2014). In the present experiments, our goal was to examine retrieval-based strategies for learning from educational texts. The three experiments reported here were carried out with children in elementary school classrooms to identify retrieval activities with the potential to promote learning as well as those that may *not* work well with young children, even though the activities are quite effective with college students.

Regardless of the students' ages, the nature of the materials, or the setting of the learning tasks, there are a few critical features of retrieval practice that must be present in order for retrieval to promote learning (see Karpicke, Lehman, & Aue, 2014). First, retrieval practice tasks must afford successful retrieval. It would be foolish merely to give children "tests" and assume that testing will promote learning, because learning is enhanced by the act of retrieval, not testing, per se. Second, retrieval practice enhances learning when learners must *reinstate a prior context* during retrieval (Karpicke & Zaromb, 2010; Karpicke et al., 2014; Lehman, Smith, & Karpicke, in press). Massed retrieval immediately after experiencing items might guarantee retrieval success, but it obviates the context reinstatement and updating processes that promote learning, so massed retrieval is ineffective (Carpenter & DeLosh, 2005; Karpicke & Bauernschmidt, 2011; Karpicke & Roediger, 2007). An effective retrieval practice task will afford both retrieval success and context reinstatement. Third, free recall tasks have features that make them especially effective for learning. Free recall provides little support in the immediate environment, so learners must engage in a great degree of context reinstatement. Free recall also requires learners to establish an organizational strategy to guide recall output, sometimes called a retrieval structure (Raaijmakers & Shiffrin, 1981), and learners must recover the individual items or elements within that structure. However, free recall may be problematic if it results in very little retrieval success, which is a risk because the task affords little external support. We had these elements of retrieval practice in mind when we conducted the present experiments.

Free recall retrieval practice has been shown to be effective in college students, and findings with college students were the impetus for the present project with elementary school children. To provide a reference point for interpreting the results reported in this article, we describe an experiment by Karpicke and Blunt (2011). In that study, college students (ages 18–22) read brief educational texts and practiced retrieval by freely recalling them. The students read the texts for 5 min, freely recalled the texts in a 10 min recall period, then reread the texts and recalled again. Performance on the recall tasks was scored as the proportion of idea units recalled. Students in Karpicke and Blunt's first experiment recalled 64% of the ideas on the first recall and improved to 81% recall after rereading the text. Practicing free recall greatly enhanced long-term retention, relative to repeatedly studying the material, on a delayed short answer test. Similar results have been obtained in other work. For instance, Karpicke and Roediger (2010) also examined free recall of brief texts and obtained similar results, with students improving from about 50% to 80% recall across multiple rereading and recall cycles. Repeated free recall produced a large enhancement on a delayed final test, relative to reading the material one time.

Karpicke and Blunt (2011) also examined another technique that is popular in educational settings known as concept mapping (Novak & Gowin, 1984). Students create concept maps by making node-and-link diagrams, where the concepts within a set of materials are represented as nodes, the relations among concepts are represented as links connecting the nodes, and labels describing the relations are written next to the links. Karpicke and Blunt had college students create concept maps while they read texts, in order to promote elaborative studying and ensure high levels of success on the task. Indeed, students were able to create concept maps easily, and on average they included about 80% of the ideas from the texts on their concept maps. Nevertheless, Karpicke and Blunt showed that practicing retrieval produced better long-term performance than elaborative studying with concept mapping, although concept mapping did produce gains relative to studying the material once.

In subsequent work, Blunt and Karpicke (2014a) showed that concept mapping could work as an effective technique when it was done as a retrieval-based learning activity. That is, when students practiced retrieval by creating concept maps without viewing the material, this retrieval-based concept mapping activity improved long-term retention to the same extent as recalling material in paragraph format (which was the retrieval practice method used by Karpicke & Blunt, 2011; Karpicke & Roediger, 2010; and Roediger & Karpicke, 2006, among others). Concept mapping is effective when it is implemented as a retrieval-based learning activity, and it may work well as a retrieval practice activity for young children. Retrieval-based concept mapping tasks could be designed to provide retrieval support, for example, by providing students with the overall relational structure of the node-and-link diagram, or by having some portion of the map already filled in for students. At the same time, the activity would still require students to practice retrieval of knowledge from a prior study context. Retrieval-based concept mapping was one of the retrieval practice techniques explored in the present experiments.

Three experiments are reported in the present article. The first experiment was an attempt to implement methods that are effective with college students, as shown by Karpicke and Blunt (2011) and other researchers, in a classroom setting with children. Fourth-grade students read brief educational texts, which were chosen in collaboration with the students' teachers from the fourth grade curriculum, and created concept maps or practiced retrieval by freely recalling the texts. The original intent of the experiment was to examine the effects of these learning activities on a delayed test, but it was immediately evident that the key results pertained to children's performance on the initial learning activities themselves. To preview, the levels of performance were surprising in light of the results typically obtained on these activities with college students. The outcome of Experiment 1 led us to explore new ways of guiding retrieval practice with children by using novel concept mapping tasks in Experiments 2 and 3.

2. Experiment 1

In Experiment 1, elementary school-age children read brief educational texts and engaged in four different learning activities. In the concept mapping condition, the children read the text and created a concept map with the text in front of them. In the free recall condition, the children read the text and then attempted to recall as much of the information from the text as they could, without the text in front of them. The children then reread the text and attempted to recall it a second time. In the cued recall condition, the children read the text and were given a sheet with sentence stems as prompts to guide them as they practiced retrieval. The children then reread the text and attempted free recall, without the sentence stems, in the second recall period. This condition allowed us to examine whether initial sentence-cued recall would aid performance during the second free recall period. Finally, for a control condition, children read the text and did not engage in any additional activity. The children then made a series of metacognitive judgments (judgments of learning and ratings of how interesting, difficult, and enjoyable they thought the activities were). The effects of the initial learning conditions were assessed on a final test four days after the original learning