Comment on "Retrieval Practice Produces More Learning than Elaborative Studying with Concept Mapping"

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Karpicke and Blunt (Reports, 11 February 2011, p. 772) reported that retrieval practice produces greater gains in learning than elaborative studying with concept mapping and concluded that this strategy is a powerful way to promote meaningful learning of complex concepts commonly found in science education. We question their findings on methodological and epistemological grounds.

Decades of research in cognitive science and information processing have established that meaningful learning depends on both the active and purposeful retrieval of relevant concepts from long-term memory and the elaboration, differentiation, and integration of those concepts in cognitive structure (*1*, *2*). Yet, Karpicke and Blunt (*3*) ask us to consider which is more effective, an instructional strategy that focuses on retrieving concepts from long-term memory (retrieval practice) or one that builds frameworks of knowledge through active engagement in the discipline (concept mapping). We welcome these findings as a stimulus to further research on the theoretical importance of retrieval and elaboration, but caution those who may read too much into their practical importance for classroom science teaching and learning. In particular, the conclusion that "[r]etrieval practice is a powerful way to promote meaningful learning of complex concepts commonly found in science education" may be taken by some as an endorsement of frequent classroom testing in lieu of recent practices in science teaching that are supported by an avalanche of research over a period of three or more decades (*4*–*6*).

A careful reading of (*3*) and its supporting online material raises additional methodological and epistemological questions. One critical issue is the relatively brief period of training and practice in concept mapping offered the research participants and the absence of evidence that they actually mastered the technique before the experiment. Were participants able to identify the most important concepts in a reading passage, organize concepts in a hierarchical manner, link concepts using appropriate semantic connectors, and cross-link the related concepts? In our own research, we have found that even strong students require multiple opportunities over an extended period of time to master the concept mapping strategy and that students improve significantly over 10 to 15 weeks with repeated intervention and feedback (*7*, *8*). In contrast, Karpicke and Blunt offered their participants a truncated description of the concept mapping technique, an example drawn from one of Novak's papers, and a 25-min period to complete the task. Given the sterile environment of a psychology laboratory and the absence of genuine guidance and feedback, we have no way of assessing the validity of the treatment. Although the authors indicate that 14 out of 20 participants in the first experiment indicated previous experience with concept mapping, we cannot assess how extensive their experience might have been. Recent cross-national studies on Panamanian school children and teachers attending 2-week, full-time workshops have produced a taxonomy and rubric of concept mapping competence and have shown the need for extensive practice and feedback when learning this strategy (*9*).

Another issue of concern is the relative familiarity of participants with the retrieval practice treatment. In this treatment, participants were told simply to "recall as much information as they could" and to type it into a response box in the computer screen. In contrast to the concept mapping treatment, retrieval practice is certainly a common experience for all students and we can assume that all undergraduate participants in this study had 12 or more years of such practice in the normal course of schooling, although the authors report no information on this. Beyond the academic setting, each of us practices retrieval in everyday life (e.g., when reading a book or recounting a recent television episode). But how many of us practice concept mapping on a daily basis? Accordingly, we conclude that a comparison of the effects of concept mapping and retrieval practice is clearly tipped in favor of the latter on the basis of relative familiarity alone.

Karpicke and Blunt claim to show that "practicing retrieval produces greater gains in meaningful learning than elaborative studying with concept mapping." Yet, one of the hallmarks of meaningful learning is enhanced retention (*10*). If so, why did the authors choose merely a 1-week interval between intervention and administration of the outcome measures? If they wish to claim that retrieval practice is superior to concept mapping, it would seem that a longer period (weeks, months, a semester or two, perhaps years) is called for.

Experienced science teachers who use concept mapping in their classrooms often begin the activity with an exercise in "stimulating recall of prior learning," as recommended by Gagne and others (*11*). Often, this takes the form of a discussion or an interactive collaborative effort that "primes" relevant concepts in long-term memory, activates a network of related ideas, and retrieves them into working memory, where they are elaborated (*12*). Novak and Gowin (*13*, *14*) suggest that students reflect on a list of "seed concepts." In this context, Karpicke and Blunt imply that science teachers fail to understand the critical role of retrieval in learning, and these authors offer recall testing as a solution. An equally plausible explanation is that good teachers choose more "classroom friendly" ways to encourage retrieval.

Finally, we wish to add a note of caution with respect to the study by Karpicke and Blunt. The authors of the study have done previous work on the effects of retrieval practice in experimental settings, but here they ventured into work on instructional practices in science teaching, drawing potentially strong implications about the relative value of each. The history of educational psychology is littered with prescriptions written in university laboratories and implemented by those with minimal understanding of the nuances and subtleties of schools, teachers, and children (witness the "teacher-proof" science projects of the 1960s). The findings of the Karpicke and Blunt study suggest that teachers would do well to pay more attention to retrieval of prior knowledge in science classrooms. In itself, this is a reasonable suggestion. Whether retrieval is best accomplished through recall testing is an open question that deserves further study.

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Editor's Summary