

Instructor Guidelines

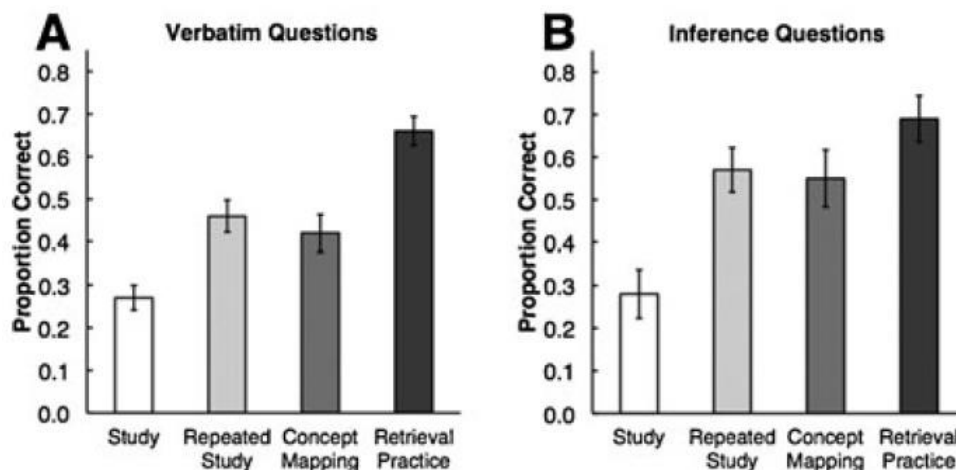
Using Retrieval Practice to Improve Student Learning in Your Classes

- Retrieval Practice – the act of trying to remember what one has previously learning or studied without looking back at the material. Synonyms: test enhanced learning, practice testing, practice quizzing, self-testing
- Test Effect – an increase in long term memory of material as a result of retrieval practice. Trying to recall previously learned material improves learning.
- Retrieval-based learning – Learning involves two major processes – encoding and retrieval. Encoding involves making sense out of new information and getting it into memory. Retrieval is the process of trying to recall information from memory. Students devote most of their study time to trying to get new information into memory, *encoding*. More time should be dedicated to *active retrieval*, which promotes meaningful, long-term learning.

Brief Overview of Retrieval Practice. Abundant research has found that retrieval practice is a potent learning strategy (Dunlosky, Rawson, Marsh, Nathan & Willingham, 2013). To illustrate, in one study researchers compared the test scores of students in four study conditions. In the learning phase of the study, each group studied the material differently.

- Group 1 Study: Students read the material one time
- Group 2 Repeated study: Students read the material four times
- Group 3 Concept mapping: Students read the material one time and then made a concept map of it
- Group 4 Retrieval practice: Students read the material one time and then wrote down everything they could remember without looking back at the information

One week after the learning/study session students took a text on the material. As shown in the figure below, the Retrieval Practice group outperformed the other groups on questions of verbatim factual information as well as inference questions that involved drawing inferences and conclusions (Karpicke & Blunt, 2011).



Source: Karpicke, J. D., & Blunt, J. R. (2011). Retrieval practice produces more learning than elaborative studying with concept mapping. *Science*, 331, 772–775. <http://dx.doi.org/10.1126/science.1199327>

It may be surprising that retrieval leads to better learning than rereading the material multiple times. We can explain the difference in terms of the mental processes involved in retrieval and rereading. In general, learning requires mental effort directed at trying to make sense of the material and integrate it with one's prior knowledge. Learning from reading involves making connections and associations among facts and ideas, in effect building a mental model of the new information. Unless students engage in these processes, rereading results in little new learning.

Why is retrieval practice an effective learning strategy? RP is effective for two reasons:

1. Whenever you try to recall information you have been learning you make new connections and associations that will help you recall it in the future. Bringing information to mind strengthens the memory and increases the chances you can recall it in the future. Retrieval practice

. . . produces direct effects on learning, because engaging in the process of retrieval itself produces learning. Every time we retrieve knowledge, that knowledge is altered, and the ability to reconstruct that knowledge again in the future is enhanced.

Karpicke & Grimaldi, 2012

In retrieving information from memory, we form new associations and connections to the material. With additional retrieval attempts, it becomes easier to recall the information.

2. When we try but can't remember information, it is a clear signal that we don't know it and need to go back and review it. Retrieval gives us feedback about what we do and do not know, information we can use to alter our study. After a disappointing test grade, students often tell their instructor, "I thought I knew this." However, there is only one accurate way to judge whether you know something – test yourself on it. If you can't produce the answer, you don't know it. RP enables you to better judge what you know and don't know. Then you can go back and fill in the missing pieces.

Rereading involves different mental processes. Studies show that rereading material one time improves learning. But additional rereading produces little improvement (Callender & McDaniel, 2018). Rereading re-exposes you to the material, which makes it more familiar on subsequent readings. In fact, increasing familiarity with the material, may lead to an "illusion of knowing," a belief that you know it (Soderstrom & Bjork, 2014). But a sense of familiarity with the material is not equivalent to knowing it. Ironically, you may invest less mental effort in rereading because you believe you know it. In this way, rereading tends to be superficial repetition of the material.

Note that rereading can be a very productive learning experience when an individual ponders a text, works out new meanings, monitors comprehension and backtracks to gain better understanding and so forth. But this kind of close, probing reading is not the typical way students read homework assignments. More commonly students are guided by the belief that repetition will produce adequate learning.

Students' beliefs about retrieval practice. Studies indicate that students tend to distrust and dislike retrieval practice because it seems both harder and less effective than other study strategies (Karpicke & Blunt, 2011). Self-testing seems harder because it requires extra mental effort and even a bit of struggle to recall what you have learned. Moreover, when students try self-testing, they are often disappointed in how little they recall. Students conclude it is ineffective compared to rereading

which produces a more satisfying sense of learning. The irony is that self-testing is an accurate measure of what students actually know, in contrast to what they believe they know from rereading.

Retrieval Practice Strategies

There are many ways to incorporate retrieval practice into classes. The following list is not exhaustive. Instructors should select strategies based on their course learning goals, course level, subject matter, student needs and so forth.

1. *Practice tests* are low stakes practice tests or quizzes prior to high stakes graded exams. Students *take* practice tests and receive feedback on their performance.
2. *Reading quizzes* involve answering questions embedded in or following reading assignments. For example, students take short online reading quizzes after each reading assignment. They receive “automated” feedback after completing each quiz. The quizzes are due a day before each class period. Some quiz items later appear on course exams.
3. *Practice quiz at the start of class* to test students’ knowledge of concepts relevant to the day’s lesson. The practice quiz serves two purposes – it involves retrieval practice and activates prior knowledge relevant to the topic.
4. *Clicker questions*. Instructors often use clicker questions to gain students’ attention or to help them work out an initial understanding of concepts in class. They can also be used for retrieval practice. Consider using clicker questions about material learned in previous class periods. Do these at the start or end of class.
5. *End of class quizzes*. Students take a quiz at the end of class. Include some questions on material from previous class periods.
6. *Minute paper*. At the end of class ask students to write a summary of the major topics and concepts from the class period. Alternatively, give them a list of the major topics from the class period and ask them to write as much as they can about each one. Periodically, ask students to write about topics and concepts from previous class periods.
7. *Self-testing*. Encourage students to use self-testing as a learning strategy. Some techniques:
 - Flashcards
 - While studying, close the book and try to write down what they remember
 - *Read-Recite-Review* as a reading/study strategy
 - After class, take 5 minutes to write down what they remember from the class/lecture without looking back at notes
 - Use Quizlet, <https://quizlet.com/latest>. Note: It is likely many students already use Quizlet or another online self-testing study app.

Guidelines for Implementing Retrieval Practice Effectively

The following guidelines are consistent with research on retrieval practice with college students.

1. Allow lag time between initial learning and retrieval practice. RP works best after students have started to forget the material. Give practice quizzes a day or two *after* students have studied or been exposed to the material (Carpenter, 2014).
2. Use spaced practice. Use *multiple* practice sessions, spread out over time. The time between practice testing sessions allows students to start to forget the material. After the delay, retrieval practice has a much stronger effect (Fiorella & Mayer; Pyc & Rawson, 2009).
3. Practice test items. Multiple choice items work. Cued recall or free recall questions work better (Fiorella & Mayer, 2015). However, multiple choice items may work better when students have very little understanding of the material (Little, Bjork, Bjork, & Angelo, 2012).
4. Multiple practice tests. In general, “more testing is better than less testing” Putnam, Nestojko & Roediger III, 2017, p. 102). Test and retest the material multiple times rather than one time.
5. Give feedback. Feedback enhances learning through RP. Instructors do not need to give individual feedback. Feedback can be in the form of correct answers or model answers that students can use to diagnose and revise answers as needed. Promote the use of feedback as a learning strategy among students (Fiorella & Mayer, 2015; Putnam, Nestojko & Roediger III, 2017).
6. Students need at least a rudimentary grasp of the material to benefit from retrieval practice. Students who are struggling to understand the subject may not benefit if they have little meaningful knowledge to retrieve. Instead, they may need more time to work on understanding the concepts.
7. RP should be a low stakes activity. Promote RP as a learning strategy and not as a form of evaluation. Assign class participation credit or minimal credit for completing retrieval tasks (Lyle & Crawford, 2011).
8. Allow and encourage students to restudy material after retrieval practice. Unless students can go back and revise their thinking, RP may not lead to better understanding of the material they did not recall or understand.
9. Use questions that test course learning objectives. Include quiz or practice test items that test your learning objectives, e.g., analytical thinking, synthesizing ideas, evaluating concepts, generating concepts or other types of thinking germane to your course and subject area. Quiz items that test only for basic knowledge will not enhance complex learning and thinking.
10. Align retrieval practice questions and course exam questions to target the same concepts. Close alignment is the most direct way to use RP to learn high importance concepts.

11. Include practice test items on graded examinations. Include the *high importance* practice questions on more than one exam, i.e., make them cumulative (Carpenter, Cepeda, Rohrer, Kang, & Pashler, 2012; Putnam, Nestojko & Roediger III, 2017).
12. Focus practice testing on core concepts. Use practice tests to enhance learning of core concepts. Use cumulative practice tests during the semester to promote long-term learning of core concepts.
13. A desirable byproduct of RP is that students may read the course material more than they would otherwise, which could have a positive effect on class activities, independent of better long-term learning.
14. Test fatigue. Students may perceive extensive practice testing as routinized, excessive, tedious busy work. Emphasize RP as “practice” and a potent way to learn and master the subject matter. To support a positive attitude toward practice testing: 1) promote RP as a learning strategy that will benefit student success, 2) make RP a low stakes activity, e.g., give students credit for completing RP tasks, 3) include RP questions on graded exams so that students see the direct connection between practice and summative assessment, 4) provide feedback so that students can adjust their learning.
15. If it ain’t broke, don’t fix it. If you already involve students regularly in deeper processing that leads to durable learning, retrieval practice *in class* may not be necessary. However, you may still encourage students to use self-testing as a study strategy.
16. Encourage students to use self-testing as a study strategy. In conjunction with the use of retrieval practice in the course, instructors should teach students about the benefits of self-testing and how to use self-testing effectively.

Encourage Students to Use Self-testing As a Study Strategy (on their own)

Students’ beliefs about retrieval practice pose a challenge for teaching. Studies show that students tend not to use self-testing, don’t like it, and see it as less effective than other strategies such as rereading and highlighting (Karpicke & Blunt, 2011). Below are some recommendations about how to support students’ use of self-testing.

1. Develop a strategy to persuade students to use self-testing. Such a strategy could include:
 - Explanations about how and why self-testing is an effective learning strategy.
 - Use of empirical evidence to show advantages of using self-testing, e.g., improve learning and grades; may reduce overall study time.
 - Promote the idea of self-testing as necessary “practice” to achieve long lasting knowledge and mastery of the subject as opposed to temporary knowledge that fades after passing exams.
 - Incentives to try out and use self-testing in the course, e.g., students receive course credit if they provide evidence of using self-testing.
 - Implement practice testing in the course and discuss with students how it supports their long-term learning.

2. Show students how to use self-testing effectively. Not all students use self-testing appropriately. Explain two important and fundamental features of effective self-testing:
 - Continue to retest even if they think they know the answer. A good rule of thumb is to answer a question correctly three times in a study session, and in three separate study sessions, i.e., answering correctly 9 times.
 - Spaced practice increases the effectiveness of practice testing. Urge students to schedule multiple self-testing sessions, spread out over time rather than study in one long session (cramming).
3. Define and explain two common pitfalls in self-testing.
 - When students think they don't know an answer, they do not try to recall it. Always try to answer a question before moving on.
 - When students assume they do know an answer to a question, they tend to skip over it without answering it. Students should always try to answer a question, even if they think they know the answer.

It is important for students to recognize that self-testing involves effort, and sometimes struggle in trying to retrieve the material. An important rule of self-testing is to always try to answer questions before looking at the answers or moving on. Advise students to try to answer a question even when they think they know the answer already or when they think they don't know the answer at all.

4. Explain that self-testing is a learning strategy. Trying to remember strengthens one's memory for material and makes it easier to recall the information in the future.
5. Explain that self-testing is an effective way to identify gaps in understanding. It is the one true indicator of one's knowledge. If you can't recall it, you don't know it. Self-testing is important feedback to guide review and re-study of the material.
6. Failing to remember is sometimes an indicator of poor comprehension. Encourage students to ask whether they really understand the material, e.g., could they explain it to someone else. If not, they may need to restudy the material.
7. [Read-Recite-Review Study Strategy](#). Urge students who have difficulty studying their course texts, to try out the Read-Recite-Review Strategy. The 3R approach incorporates retrieval practice, and is more effective than rereading and note taking. Students **read** a passage in the text, and then try to **recite** (retrieve) as much of the material as they can out loud without looking at the text. They go back and **review** the passage to identify errors or gaps in their knowledge. Encouraging students to give up their routine study habits and adopt a new approach is a hard sell. Emphasize that research shows that 3R works better than rereading and takes less time. Suggest they try it out, especially if they are having difficulty remembering material in the course. Highlight the importance of trying to remember – even when it is difficult and seems like it is ineffective. Working harder to remember the material creates stronger memory for the material.