



Six research-tested ways to study better

Psychology's latest insights for preparing students for their next exams.

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Many students are missing a lesson in a key area that can help guarantee their success: how to study effectively.

It's common for students to prepare for exams by re-reading class notes and cramming textbook chapters—study techniques that hinge on the assumption that memories are like recording devices that can play back memories during an exam. “But the storage and retrieval operations of human memory differ from recording devices in almost every

way possible,” says psychology professor Robert Bjork, PhD, co-director of the Learning and Forgetting Lab at University of California, Los Angeles.

What does help our brains retain information? Study strategies that require the brain to work to remember information—rather than passively reviewing material.

Bjork coined the term “desirable difficulty” to describe this concept, and psychologists are homing in on exactly how students can develop techniques to maximize the cognitive benefits of their study time.

Here are six research-tested strategies from psychology educators.

1. Remember and repeat

Study methods that involve remembering information more than once—known as repeated retrieval practice—are ideal because each time a memory is recovered, it becomes more accessible in the future, explains Jeffrey Karpicke, PhD, a psychology researcher at Purdue University in Indiana who studies human learning and memory.

The benefits of this technique were evident when Karpicke conducted a study in which students attempted to learn a list of foreign language words. Participants learned the words in one of four ways:

- Studying the list once.
- Studying until they had successfully recalled each word once.
- Studying until they had successfully recalled each word three times consecutively.
- Studying until they had recalled each word three times spaced throughout the 30-minute learning session.

In the last condition, the students would move on to other words after correctly recalling a word once, then recall it again after practicing other words.

A week later, the researchers tested the students on the words and discovered that participants who had practiced with repeated spaced retrieval—the last condition—far

outperformed the other groups. Students in this group remembered 80% of the words, compared to 30% for those who had recalled the information three times in a row—known as massed retrieval practice—or once. The first group, which involved no recall, remembered the words less than 1% of the time (*Journal of Experimental Psychology: Learning, Memory, and Cognition* (PDF, 288KB) (http://learninglab.psych.purdue.edu/downloads/2011_Karpicke_Bauernschmidt_JEPLMC.pdf), Vol. 37, No. 5, 2011).

Many students assume that recalling something they've learned once is proof that they've memorized it. But, says Karpicke, just because you can retrieve a fact in a study session doesn't mean you will remember it later on a test. "Just a few repeated retrievals can produce significant effects, and it's best to do this in a spaced fashion."

2. Adapt your favorite strategies

Other research finds support for online flashcard programs, such as Study Stack or Chegg, to practice retrieving information—as long as students continue retesting themselves in the days leading up to the test, says John Dunlosky, PhD, who studies self-regulated learning at Kent State University in Ohio. For flashcards with single-word answers, the evidence suggests that thinking of the answer is effective, but for longer responses like definitions, students should type, write down, or say aloud the answers, Dunlosky says. If the answer is incorrect, then study the correct one and practice again later in the study session. "They should continue doing that until they are correct, and then repeat the process in a couple more days," he says.

Concept mapping — a diagram that depicts relationships between concepts—is another well-known learning technique that has become popular, but cognitive psychology researchers caution students to use this strategy only if they try to create a map with the book closed. Karpicke demonstrated this in a study in which students studied topics by creating concept maps or by writing notes in two different conditions: with an open textbook or with the textbook closed. With the closed textbook, they were recalling as much as they could remember. One week later, the students took an exam that tested their knowledge of the material, and students who had practiced retrieving the information with the book closed had better performances (*Journal of Educational*

Psychology (<https://psycnet.apa.org/doiLanding?doi=10.1037%2Fa0035934>), Vol. 106, No. 3, 2014).

“Concept maps can be useful, as long as students engage in retrieval practice while using this strategy,” Karpicke says.

3. Quiz yourself

Students should also take advantage of quizzes—from teachers, in textbooks or apps like Quizlet—to refine their ability to retain and recall information. It works even if students answer incorrectly on these quizzes, says Oregon State University psychology professor Regan Gurung, PhD. “Even the process of trying and failing is better than not trying at all,” he says. “Just attempting to retrieve something helps you solidify it in your memory.”

Gurung investigated different approaches to using quizzes in nine introductory psychology courses throughout the country. In the study, the researchers worked with instructors who agreed to participate in different conditions. Some required students to complete chapter quizzes once while others required them to take each quiz multiple times. Also, some students were told to complete all the chapter quizzes by one deadline before the exam, while others were expected to space their quizzes by meeting deadlines throughout the course. The students who spaced their quizzes and took them multiple times fared the best on the class exams (*Applied Cognitive Psychology* (<https://onlinelibrary.wiley.com/doi/abs/10.1002/acp.3507>), Vol. 33, No. 5, 2019).

Although trying and failing on practice quizzes may be an effective study strategy, psychology professor Nate Kornell, PhD, of Williams College in Massachusetts, was skeptical that students would choose to learn this way because many people inherently do not like getting things wrong. He was eager to explore whether it was possible to create a retrieval practice strategy that increased the odds of students getting the right answer without sacrificing the quality of learning. To test this possibility, he led a study in which participants tried to remember word pairs, such as “idea: seeker.” The goal was to remember the second word after seeing only the first one. The students could choose to practice by restudying all the pairs or by self-testing with different options for hints—seeing either two or four letters of the second word in the pair, or no letters at all

(Cognitive Research: Principles and Implications

(<https://cognitiveresearchjournal.springeropen.com/articles/10.1186/s41235-019-0187-y>), Vol. 4, 2019).

Most of the students preferred self-testing over restudying, and the results showed that even with hints, the self-testing group performed better on the final test of the words than the restudying group. “It’s a win-win situation because the technique that worked most effectively was also the one that they enjoyed the most,” says Kornell.

Even more important, students think they are learning more effectively when they answer correctly while practicing, which means they’ll be even more motivated to try retrieval practice if hints are available, says Kornell. To apply this strategy, he suggests adding hints to self-generated flash cards or quizzes, such as the first letter of the answer or one of the words in a definition.

4. Make the most of study groups

Many students also enjoy studying with classmates. But when working in groups, it’s important for students to let everyone have an opportunity to think of the answers independently, says Henry Roediger, III, PhD, a professor in the psychology department at Washington University in St. Louis. One study highlighted the importance of this: Participants tried to learn words in a foreign language by either answering aloud or by listening to their partners give the answers (*Journal of Experimental Psychology: Applied* (PDF, 426KB) (<http://psychnet.wustl.edu/memory/wp-content/uploads/2018/12/AbelRoediger2018.pdf>), Vol. 24, No. 3, 2018). As expected, those who had answered aloud outperformed the listeners on a test two days later. The researchers also compared participants who answered aloud with partners who silently tried to recall the answers. Everyone received feedback about whether they had gotten the correct answer. Both groups had comparable performances. “Waiting for others to think of answers may slow down the process, but it produces better retention for everyone because it requires individual effort,” Roediger says.

5. Mix it up

Researchers have also investigated the potential benefits of “interleaving,” or studying for different courses in one study session (*Journal of Experimental Psychology: Applied* (<https://psycnet.apa.org/doiLanding?doi=10.1037%2Fxp0000139>), Vol. 23, Nov. 4, 2017). For example, rather than dedicating two hours to studying for a psychology exam, students could use that time to study for exams in psychology, biology and statistics courses. A few days later, students could study for the same courses again during another block of time. “This strategy, versus blocking one’s study by course, naturally introduces spacing, so students practice retrieving information over time,” Bjork says.

But the research on interleaving has had mixed results, says Aaron Richmond, PhD, a professor of educational psychology and human development at Metropolitan State University in Denver. “If the concepts from two subjects overlap too closely, then this could interfere with learning,” says Richmond. “But chemistry and introduction to psychology are so different that this doesn’t create interference.”

6. Figure out what works for you

The ability to effectively evaluate one’s approach to learning and level of attainment is known as metacognitive ability. Research has shown that “when people are new to learning about a topic, their subjective impressions of how much they know are the most inflated,” says Paul Penn, PhD, a senior lecturer in the psychology department at East London University and author of the 2019 book “The Psychology of Effective Studying.”

“If your impression of your learning is inflated, you have little incentive to look at the way you’re approaching learning,” he says.

To increase awareness about the value of sound study strategies, administrators at Samford University in Alabama invited psychology professor Stephen Chew, PhD, to talk to first-year students about this topic during an annual convocation each fall semester. Though an assessment study, he realized that the lecture prompted immediate changes in beliefs and attitudes about studying, but long-term change was lacking. “Students forgot the specifics of the lecture and fell back into old habits under the stress of the semester,” Chew says.

To provide an accessible resource, he launched a series (<https://www.samford.edu/departments/academic-success-center/how-to-study>) of five 7-minute videos on the common misconceptions about studying, how to optimize learning and more. Professors throughout the school assign the videos as required classwork, and the videos have been viewed 3 million times throughout the world by high school, college and medical students.

While this form of campus-wide education about studying is somewhat rare, psychology researchers are optimistic that this could become more common in the coming years. “There is a lot more discussion now than even 10 years ago among teachers about the science of learning,” Karpicke says. “Most students do not know how to study effectively, and teachers are increasingly eager to change that.”

Further reading

- [Improving Self-Regulated Learning with a Retrieval Practice Intervention \(PDF, 923KB\)](http://learninglab.psych.purdue.edu/downloads/2018_Ariel_Karpicke_JEPA.pdf) (http://learninglab.psych.purdue.edu/downloads/2018_Ariel_Karpicke_JEPA.pdf). Ariel, R., Karpicke, J.D., *Journal of Experimental Psychology: Applied*, 2018.
- [Practice Tests, Spaced Practice, and Successive Relearning: Tips for Classroom Use and for Guiding Students' Learning \(PDF, 53KB\)](https://pubs/journals/features/stl-0000024.pdf) ([/pubs/journals/features/stl-0000024.pdf](https://pubs/journals/features/stl-0000024.pdf)). *Scholarship of Teaching and Learning in Psychology*, Dunlosky, J. & Rawson, K.A., 2015.
- [Performance Bias: Why Judgments of Learning Are not Affected by Learning](https://link.springer.com/article/10.3758/s13421-017-0740-1) (<https://link.springer.com/article/10.3758/s13421-017-0740-1>). Kornell, N. and Hausman, H., *Memory & Cognition*, 2017.

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