

To Really Learn, Quit Studying and Take a Test

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Taking a test is not just a passive mechanism for assessing how much people know, according to new research. It actually helps people learn, and it works better than a number of other studying techniques. The research, published online Thursday in the journal *Science*, found that students who read a passage, then took a test asking them to recall what they had read, retained about 50 percent more of the information a week later than students who used two other methods.

One of those methods — repeatedly studying the material — is familiar to legions of students who cram before exams. The other — having students draw detailed diagrams documenting what they are learning — is prized by many teachers because it forces students to make connections among facts. These other methods not only are popular, the researchers reported; they also seem to give students the illusion that they know material better than they do. In the experiments, the students were asked to predict how much they would remember a week after using one of the methods to learn the material. Those who took the test after reading the passage predicted they would remember less than the other students predicted — but the results were just the opposite.

“I think that learning is all about retrieving, all about reconstructing our knowledge,” said the lead author, Jeffrey Karpicke, an assistant professor of psychology at Purdue University. “I think that we’re tapping into something fundamental about how the mind works when we talk about retrieval.” Several cognitive scientists and education experts said the results were striking. The students who took the recall tests may “recognize some gaps in their knowledge,” said Marcia Linn, an education professor at the University of California, Berkeley, “and they might revisit the ideas in the back of their mind or the front of their mind.” When they are later asked what they have learned, she went on, they can more easily “retrieve it and organize the knowledge that they have in a way that makes sense to them.”

The researchers engaged 200 college students in two experiments, assigning them to read several paragraphs about a scientific subject — how the digestive system works, for example, or the different types of vertebrate muscle tissue. In the first experiment, the students were divided into four groups. One did nothing more than read the text for five minutes. Another studied the passage in four consecutive five-minute sessions.

A third group engaged in “concept mapping,” in which, with the passage in front of them, they arranged information from the passage into a kind of diagram, writing details and ideas in hand-drawn bubbles and linking the bubbles in an organized way. The final group took a “retrieval practice” test. Without the passage in front of them, they wrote what they remembered in a free-form essay for 10 minutes. Then they reread the passage and took another retrieval practice test. A week later all four groups were given a short-answer test that assessed their ability to recall facts and draw logical conclusions based on the facts.

The second experiment focused only on concept mapping and retrieval practice testing, with each student doing an exercise using each method. In this initial phase, researchers reported, students who made diagrams while consulting the passage included more detail than students asked to recall what they had just read in an essay. But when they were evaluated a week later, the students in the testing group did much better than the concept mappers. They even did better when they were evaluated not with a short-answer test but with a test requiring them to draw a concept map from memory.

Why retrieval testing helps is still unknown. Perhaps it is because by remembering information we are organizing it and creating cues and connections that our brains later recognize. “When you’re retrieving something out of a computer’s memory, you don’t change anything — it’s simple playback,” said Robert Bjork, a psychologist at the University of California, Los Angeles, who was not involved with the study. But “when we use our memories by retrieving things, we change our access” to that information, Dr. Bjork said. “What we recall becomes more recallable in the future. In a sense you are practicing what you are going to need to do later.” It may also be that the struggle involved in recalling something helps reinforce it in our brains. Maybe that is also why students who took retrieval practice tests were less confident about how they would perform a week later.

“The struggle helps you learn, but it makes you feel like you’re not learning,” said Nate Kornell, a psychologist at Williams College. “You feel like: ‘I don’t know it that well. This is hard and I’m having trouble coming up with this information.’ ” By contrast, he said, when rereading texts and possibly even drawing diagrams, “you say: ‘Oh, this is easier. I read this already.’ ” The Purdue study supports findings of a recent spate of research showing learning benefits from testing, including benefits when students get questions wrong. But by comparing testing with other methods, the study goes further. “It really bumps it up a level of importance by contrasting it with concept mapping, which many educators think of as sort of the gold standard,” said Daniel Willingham, a psychology professor at the University of Virginia. Although “it’s not totally obvious that this is shovel-ready — put it in the classroom and it’s good to go — for educators this ought to be a big deal.”

Howard Gardner, an education professor at Harvard who advocates constructivism — the idea that children should discover their own approach to learning, emphasizing reasoning over memorization — said in an e-mail that the results “throw down the gauntlet to those progressive educators, myself included.” “Educators who embrace seemingly more active approaches, like concept mapping,” he continued, “are challenged to devise outcome measures that can demonstrate the superiority of such constructivist approaches.”

Testing, of course, is a highly charged issue in education, drawing criticism that too much promotes rote learning, swallows valuable time for learning new things and causes excessive student anxiety. “More testing isn’t necessarily better,” said Dr. Linn, who said her work with California school districts had found that asking students to explain what they did in a science experiment rather than having them simply conduct the hands-on experiment — a version of retrieval practice testing — was beneficial. “Some tests are just not learning opportunities. We need a different kind of testing than we currently have.”

Dr. Kornell said that “even though in the short term it may seem like a waste of time,” retrieval practice appears to “make things stick in a way that may not be used in the classroom. “It’s going to last for the rest of their schooling, and potentially for the rest of their lives.”