



SUNDAYREVIEW

How Tests Make Us Smarter

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Gray Matter

By HENRY L. ROEDIGER III

TESTS have a bad reputation in education circles these days: They take time, the critics say, put students under pressure and, in the case of standardized testing, crowd out other educational priorities. But the truth is that, used properly, testing as part of an educational routine provides an important tool not just to measure learning, but to promote it.

In one study I published with Jeffrey D. Karpicke, a psychologist at Purdue, we assessed how well students remembered material they had read. After an initial reading, students were tested on some passages by being given a blank sheet of paper and asked to recall as much as possible. They recalled about 70 percent of the ideas.

Other passages were not tested but were reread, and thus 100 percent of the ideas were re-exposed. In final tests given either two days or a week later, the passages that had been tested just after reading were remembered much better than those that had been reread.

What's at work here? When students are tested, they are required to retrieve knowledge from memory. Much educational activity, such as lectures and textbook readings, is aimed at helping students acquire and store knowledge. Various kinds of testing, though, when used appropriately, encourage students to practice the valuable skill of retrieving and using knowledge. The fact of improved retention after a quiz — called the testing effect or the retrieval practice effect — makes the learning stronger and embeds it more securely in memory.

This is vital, because many studies reveal that much of what we learn is

quickly forgotten. Thus a central challenge to learning is finding a way to stem forgetting.

The question is how to structure and use tests effectively. One insight that we and other researchers have uncovered is that tests serve students best when they're integrated into the regular business of learning and the stakes are not make-or-break, as in standardized testing. That means, among other things, testing new learning within the context of regular classes and study routines.

Students in classes with a regimen of regular low- or no-stakes quizzing carry their learning forward through the term, like compounded interest, and they come to embrace the regimen, even if they are skeptical at first. A little studying suffices at exam time — no cramming required.

Moreover, retrieving knowledge from memory is more beneficial when practice sessions are spaced out so that some forgetting occurs before you try to retrieve again. The added effort required to recall the information makes learning stronger. It also helps when retrieval practice is mixed up — whether you're practicing hitting different kinds of baseball pitches or solving different solid geometry problems in a random sequence, you are better able later to discriminate what kind of pitch or geometry problem you're facing and find the correct solution.

Surprisingly, researchers have also found that the most common study strategies — like underlining, highlighting and rereading — create illusions of mastery but are largely wasted effort, because they do not involve practice in accessing or applying what the students know.

When my colleagues and I took our research out of the lab and into a Columbia, Ill., middle school class, we found that students earned an average grade of A- on material that had been presented in class once and subsequently quizzed three times, compared with a C+ on material that had been presented in the same way and reviewed three times but not quizzed. The benefit of quizzing remained in a follow-up test eight months later.

Notably, Mary Pat Wenderoth, a biology professor at the University of Washington, has found that this benefit holds for women and underrepresented minorities, two groups that sometimes experience a high

washout rate in fields like the sciences.

This isn't just a matter of teaching students to be better test takers. As learners encounter increasingly complex ideas, a regimen of retrieval practice helps them to form more sophisticated mental structures that can be applied later in different circumstances. Think of the jet pilot in the flight simulator, training to handle midair emergencies. Just as it is with the multiplication tables, so it is with complex concepts and skills: effortful, varied practice builds mastery.

We need to change the way we think about testing. It shouldn't be a white-knuckle finale to a semester's work, but the means by which students progress from the start of a semester to its finish, locking in learning along the way and redirecting their effort to areas of weakness where more work is needed to achieve proficiency.

Standardized testing is in some respects a quest for more rigor in public education. We can achieve rigor in a different way. We can instruct teachers on the use of low-stakes quizzing in class. We can teach students the benefits of retrieval practice and how to use it in their studying outside class. These steps cost little and cultivate habits of successful learning that will serve students throughout their lives.

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