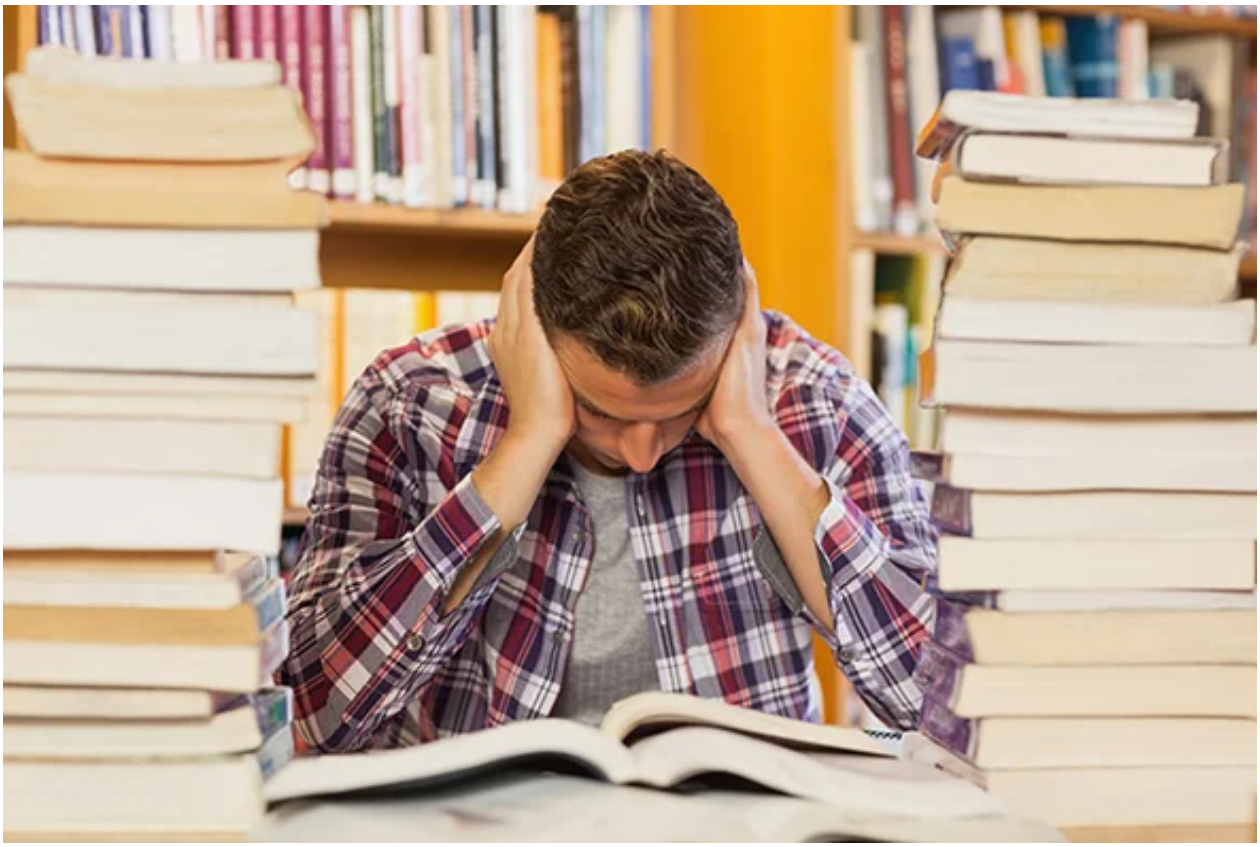
Studies show that spacing out learning over time works best

By Annie Murphy Paul on August 1, 2015



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Nate Kornell would like to see a big step forward in the methods students use to prepare for tests. Kornell is a professor of psychology at Williams College whose research focuses on effective learning strategies. Teachers and students often do not employ such scientifically supported strategies, he notes—in part because superficial tests do not

make them necessary. He offers two examples of instructional practices that could come into wider use if tests themselves made more rigorous demands.

The first is *distributed practice*, or spacing out exposures to the material to be learned at intervals spread out in time. The opposite of distributed practice—cramming—is the technique that now reigns in schools, and that's true for a reason. "When tests emphasize superficial knowledge of facts, reviewing the day before, or cramming the night before, actually works pretty well," Kornell says. "It's all really fresh in the students' minds, and they can disgorge it and get a decent score on the test."

But, he says, that crammed-in material does not stay in the student's memory for long. "A day or two after the test, it's gone—seriously gone, as if they'd never learned it in the first place," he says. Tests that ask more thoughtful and complex questions would be resistant to the strategy of cramming and last minute review. Instead, students and teachers might discover the rewards of distributed practice, returning again and again to the same material while adding more depth and nuance each time. A significant body of research shows that such distributed practice leads to more accurate and more durable learning. For example, in a study of fifth-graders published in *Applied Cognitive Psychology* in 2011, lead author Hailey Sobel of McGill University reported that students who learned definitions of vocabulary words on a spaced-out schedule remembered three times as many definitions as students who spent the same amount of time learning the material in a single session.

One instructor who has seen its benefits firsthand is Samantha Carr, a French teacher at Arroyo High School in El Monte, Calif. She uses a mobile flash card and quiz app called StudyBlue to spread out her students' learning over the course of the semester. "I know that my students can pull an all-nighter and then come into class on test day and dump it out on the page," Carr says. "But I also know that cramming like that won't lead them to retain that knowledge over the long term. The app makes it easy for them to encounter the same material repeatedly over time, right on their own smartphones."

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Another instructional practice that might attract more adherents if tests were made more challenging is *interleaving*, or mixing up different types of problems during practice sessions. The way math is currently taught, "students typically work a set of practice problems devoted to the immediately preceding lesson, which means they often know the appropriate strategy for each problem before they read the problem," says Douglas Rohrer, professor of psychology at the University of South Florida. "For instance, students might watch their teacher solve a few equations by factoring, and then solve a dozen equations by factoring."

When problem sets are arranged this way, students' performance rapidly improves. If they take a test with a similar format, they will likely do well. But they haven't learned much that will stick with them in the long term because they haven't practiced the most important skill of all: figuring out at the outset *what type of problem this is*. In order to give students practice at this kind of discernment, problems within class and homework assignments need to be interleaved—mixed up, all jumbled together, so that the student never knows in advance which type of problem she will be confronting but needs to figure it out afresh each time.

Rohrer has conducted a number of studies of interleaving in the laboratory; more recently, he has been trying out the technique with seventh-graders at Liberty Middle School in Tampa, Fla. In a study published last year in the *Journal of Educational Psychology* Rohrer and his two co-authors asked half of the 126 participating students to complete daily practice problems that were arranged by type: a set of graph problems, followed by a set of slope problems. The other students got the same problems, but mixed up: slope problems and graph problems presented in an unpredictable shuffle.

After three months all the students were led through a review session, and a day later took a test. The students who had been engaging in interleaved practice got 80 percent of the test questions right, compared with 64 percent on the part of students who had been completing blocked assignments—a not-inconsiderable difference. But the real value of interleaving became apparent when the students were tested a full month after the review session. On that test the interleaved students scored 74 percent, the blocked ones a paltry 42 percent.

Both distributed practice and interleaving enhance learning in part because they introduce what University of California, Los Angeles, psychologist Robert Bjork has termed “desirable difficulties”—that is, they make learning *harder*. For that reason, these techniques may require some adjustment. Jen DeMik is one of the teachers at Liberty Middle School who participated in Rohrer’s study; the experiment is now over but she continues to interleave the problems in her students’ assignments as often as possible. “It took a while for the kids to get used to it,” DeMik notes, “but after a while they could see that it was a better way to learn.”

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