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students remember this?" will be "ideally, forever." That goal indicates that students should revisit crucial material in subsequent years. But, of course, repetition need not be exact and can be incorporated into more advanced material.

Cramming isn't a good strategy even for shorter-term learning. The fact is, many students simply aren't that good at arranging their time or don't make scheduling study sessions a priority. For these students, infrequent tests mean infrequent studying. Teachers can discourage cramming and encourage students to keep up with the content by giving frequent low-stakes quizzes or frequent assignments that require some study.

Interleaved Practice

Suppose a student plans to spend an hour studying Spanish vocabulary on a particular night. Would it be better for her to study an individual word until she feels she's mastered it—or mix up the word list?

It seems intuitive that it's better to study the whole list rather than focus on one word at a time. This strategy is called *interleaving*, and it applies not just to a single list but to broader

principles. For example, if you're trying to learn what makes a Monet look like a Monet, it's helpful to contrast his paintings with those of other impressionists, and that's easier to do if you see a Cassatt or Renoir right after seeing a Monet (Kornell & Bjork, 2008).

As obvious as this principle seems, it's seldom observed in science and math textbooks. Typically, a new concept is introduced in a chapter; some sample problems are solved step-by-step; and a set of practice problems appears at the end of the chapter, all of which draw on the same concept algorithm. The drawback is that the student gets no practice discerning one type of problem from another; he knows that each problem in the set calls for the same basic strategy.

Implementing interleaved practice is not terribly difficult, but it does call for a bit of planning. What's needed is study and practice of different concepts *within a single session*. If curricular materials aren't set up for this sort of learning, it's up to the teacher to do a cut-and-paste job.

Another difficulty is that students feel they're learning less, not more, and indeed, they have a tougher time when

problems are interleaved. This makes sense: If a homework assignment asks the student to do 15 problems, all of them variants on the same mathematical algorithm, the student will have an easier time than if the 15 problems call for any of five different algorithms. But even as the student struggles with the latter assignment, she's learning when to use which algorithm. Teachers who use interleaving should suggest various strategies that students might use to identify different problem types. Later, perhaps on a unit test, that practice will pay off—but now the student who practiced one problem type at a time will struggle (Taylor & Rohrer, 2010).

Practice Testing

This final technique has something in common with the retrieval called for in interleaved practice: It feels to the student like it doesn't work. But rooting around in memory, trying (perhaps struggling) to remember something, is actually a great way to ensure that the memory sticks. Because the student may struggle (and even fail) to remember, it feels fruitless; wouldn't time be better spent reading over the material again? But study after study shows that taking a brief quiz is better for memory than rereading (Agarwal, Bain, & Chamberlain, 2012). The largest benefit to memory occurs when the student gets immediate corrective feedback. But even if there's no feedback, and even if the student fails to remember the answer, the quiz is still better for memory than rereading!

Further, the boost to memory can be quite long-lasting. For example, in one experiment (McDaniel, Agarwal, Huelser, McDermott, & Roediger, 2011), 8th graders took three low-stakes quizzes over the course of a science unit. On an end-of-unit test, students scored 13–25 percent better on the material that had appeared on the quizzes. (The questions probed