

Small Changes in Teaching: Space It Out

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In the last week of the spring semester, and the waning moments of class, a student raised her hand and, in a voice filled with dread, posed the question that I suspect many students wanted to ask: "Will the final exam be cumulative?" She and her classmates already knew the answer, since all of my exams are at least partially cumulative, but perhaps they were hoping I would have a change of heart before the final.

"Of course," I said, in my best deadpan. "If the final exam only covered the last five weeks of the semester, that would tell you that I don't care anymore about the material you learned in the first five weeks. And that," I concluded with a smile, "is most certainly not true." She returned my wry smile, making clear that she understood my answer but didn't much care for it.

Had that exchange occurred at the beginning of class, I probably would have delved into a long explanation of why all of my exams — not just the final — are cumulative, at least in part. I would have introduced my students to a principle that researchers have been affirming for years now: Nothing strengthens learning like spacing it out over time. The more opportunities we can give people to learn something — and the more we spread those opportunities over an extended time period — the more we help them create deep, durable learning.

You already know this from your own experience. Think of a topic that you know best: How did you acquire that knowledge? Your disciplinary knowledge, for one, developed over a very long period of time, and continues to grow with new and repeated exposures to the subject. But consider other skills you have. Did you learn to ski by spending a day on the mountain, and then have it mastered? Or did you come back again and again, improving a little each time? Did you learn a new language by spending a week studying 12 hours a day, and then have it locked into your

head? Or did you learn it slowly over months and years, with repeated exposure to the language?

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Now consider a topic you studied intensely a while back and never returned to again. How well do you know it now? A couple of years ago I was invited to give some faculty workshops in Armenia, and spent time before and during my visit studying the Armenian genocide. When I walked out of the genocide museum in Yerevan, after all that study, I felt like an expert. If you had given me an exam on the subject then, I would have aced it. However, I haven't been back to that material since. If you gave me a quiz on the basics of the Armenian genocide right now, I would likely be mortified at my score.

That tells us something important: Intensive, short-term learning often feels durable in the moment but then fades away — which is why students can do very well on noncumulative exams, and then tank a cumulative final. Cramming works for the short term. But without spaced exposure, learning dims quickly.

What we know from experience has been affirmed by many studies of how learning works. Here is a simple example: In a study from the early 1980s, researchers evaluated two groups of high-school students who were learning new French vocabulary words. The students studied the words in the exact same way, and for the exact same length of time, with one exception: The first group had a single, 30-minute study period, while the second group had three 10-minute study periods spread over three days.

On an initial exam after the study periods had concluded, the two groups performed exactly the same, averaging 16 correct answers out of 20. Thus, in the short term, spaced and nonspaced learning worked equally well. Then the researchers brought back both groups a week later, with no advance warning, and gave them a final test. The nonspaced learners remembered an average of 11 words out of 20; the spaced learners, 15.

Similar findings appear throughout the literature on human learning. In his 2015 book, *How We Learn: The Surprising Truth About When, Where,*

and Why It Happens, Benedict Carey writes about the power of spaced learning: "Nothing in learning science comes close in terms of immediate, significant, and reliable improvements to learning." The authors of *Make It Stick: The Science of Successful Learning* delve more into the mechanics: "Embedding new learning in long-term memory requires a process of consolidation, in which memory traces ... are strengthened, given meaning, and connected to prior knowledge." That process of consolidation, the authors explain, requires the essential ingredient of time.

Make all assessments (at least partially) cumulative. Whatever material you want students to retain beyond the confines of your course should make multiple appearances throughout the semester, especially on your tests. The more often the students have to retrieve, use, and reflect upon the course material, the more opportunities you are giving them to learn it deeply. Focusing assessments on recently covered material is good practice — just make sure that each assessment also draws from earlier material.

After the first test, set aside some percentage of every exam after that for questions on older content or skills. For example, out of 100 multiple-choice questions, reserve 10 or 25 for material from previous units. Or make sure one of your four essay questions requires students to reach back to earlier course content. Seeding cumulative elements into each exam — and letting students know up front that you'll be doing that — will ensure that they continue to study or practice the earlier material.

You can do the same thing with quizzes, papers, projects, or assessments of any kind. Consider how each of these types of assignments draws deliberately from previously covered material, and creates opportunities to retrieve and practice what students have learned throughout the semester.

Students may not — OK, will not — like the fact that all exams or assignments are cumulative. But they will learn better (although they probably won't ever thank you for that).

The spaced syllabus. It shouldn't just be a document students read during the first week of class and rarely consult again. Have students bring the syllabus to every class, and use it. Every other week set aside a little class time for an exercise: Pick a date on the syllabus from earlier in the semester and give a no-stakes quiz on that day's content. Or ask students to spend five minutes writing about how today's material compares with that of an earlier class session.

In my own courses, I have students do such exercises in their "commonplace books" (i.e., notebooks in which they write about the connections between the course material and their lives outside the classroom). For example, near the end of the semester in my British-literature survey course, I asked my students to look over the syllabus and write a paragraph about whatever material in the course proved most meaningful to them personally. You can adapt this approach to any discipline. The point is simply to use your syllabus in creative ways that will lead students to revisit earlier material via writing, practicing, or reflection.

Space out your deadlines and tests. This one should almost go without saying, but I'll say it anyway. As much as you can manage to do so without overburdening yourself, give frequent, spaced opportunities for students to practice and demonstrate their learning. Six moderately sized exams will leverage the power of spaced learning more than three major ones. Multiple short papers will beat that one long one, and will better prepare your students for that one long one. Weekly quizzes, writing exercises, or problem-solving sessions will help even more.

You may think, "My students are doing just fine with a midterm and final, thank you very much." Sure, maybe they do well on those exams. But remember those students in the French vocabulary experiment? They all did equally well on the initial quiz. The power of spaced learning didn't emerge until much later. The same may be true of your students: They are cramming and doing just fine on your two exams — but they may not be retaining much after the semester ends. Frequent, spaced assessments will give them a better chance to carry their learning past the final exam.

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