SUMMARY Rohrer, D., & Taylor, K. (2006). The effects of overlearning and distributed practice on the retention of mathematics knowledge. *Applied Cognitive Psychology*, *20*, 1209-1224.

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Introduction

Numerous studies have shown that many students lack proficiency in basic mathematics skills, but we believe that, for many students, these skills are learned but later forgotten. The present study examined how the long-term retention of mathematics knowledge is affected by either increasing the number of practice problems solved in a single session or dividing a given number of problems across two sessions.

Overlearning occurs when students master a skill and then immediately continue to practice the same skill. For example, once a student has correctly solved a few problems of the same type, further problems of the same type during the same session constitute overlearning. This strategy is widely advocated by educators.

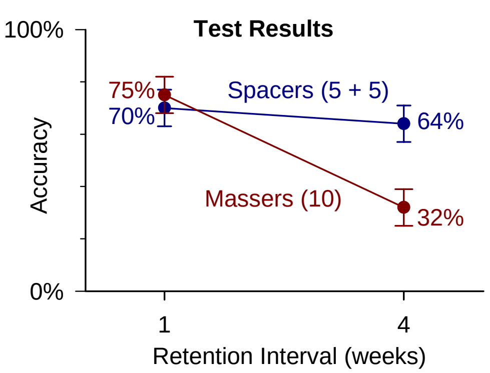
Distributed or *spaced practice* requires that a given amount of practice be divided across multiple sessions and not *massed* into one session. For example, a dozen problems of the same type can be solved in one evening or divided across two evenings. Except at very brief retention intervals, spaced practice is usually superior to massed practice – a finding known as the spacing effect. Yet some have questioned whether spaced practice is superior for tasks that require abstract thinking and not only rote memory. Also, several previous mathematics learning experiments, all purporting to show a spacing effect, were confounded in favor of the spacing effect.

Task

Students learned how to find the number of permutations for a letter sequence with at least one repeated letter. For example, the sequence *abbcc* has 30 permutations. No student saw the same sequence twice. A study with 50 USF students revealed that none were able to solve this kind of problem.

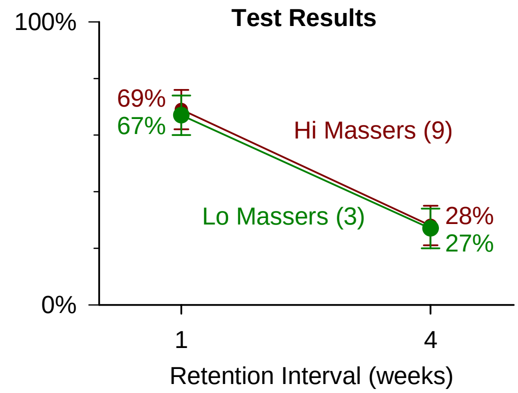
Experiment 1

After learning the task, 116 USF students worked 10 practice problems that were either massed in one session or spaced across two sessions separated by one week. They were tested 1 or 4 weeks later.



Experiment 2

After learning the task, 100 USF students worked 3 or 9 practice problems in the same session. Students were tested 1 or 4 weeks later.



Discussion

Long-term retention was boosted by distributing rather than massing problems (Experiment 1). By contrast, an increase in the number of same session problems did not affect test scores (Experiment 2). Thus, these data suggest that massed practice and overlearning produce poor long-term retention.

Yet overlearning and massed practice are fostered by the format of most mathematics textbooks. In these texts, virtually all of the problems relating to a given topic are massed into one assignment, and the number of the problems is enough to produce overlearning.

Mathematics textbooks can easily adopt a distributed-practice format by simply distributing the problems on a given topic across assignments. For example, after a topic is learned, the corresponding problems could appear once or twice each night for a few weeks and once every few weeks thereafter. (This format is used in mathematics textbooks from Saxon Publishers; neither author is affiliated with this company.) This rearrangement would not increase the total number of problems, and it would not affect the nature of the lessons preceding each assignment.

That mathematics retention needs improvement is not in dispute, especially in the United States. In one recent report on mathematics achievement from the U.S. Department of Education, less than one third of U.S. students received a rating of “at or above proficient” (Wirt et al., 2004). Such reports often lead people to conclude that students are not learning, but it is possible that many mathematical concepts are learned but later forgotten. The prevalence of such forgetting is not surprising in light of the present findings suggesting that the most popular practice schedules are designed to minimize long-term retention.