

Do Dental Students Use Optimal Study Strategies?

Maureen McAndrew, DDS, MEd; Rajit S. Kamboj; Gaëlle C. Pierre, PhD

Abstract: Research on human learning has shown that repeated retrieval practice or self-testing maximizes learning. However, recent studies have found undergraduate students to be largely unaware of the benefits of self-testing. The aim of this study was to examine dental students' study strategies and utilization of retrieval techniques for learning. All second-year dental students at New York University College of Dentistry were invited to participate. Of the total 360 students, 66 completed the two-question survey, for a response rate of 18.3%. The first question asked students to choose from a list of twelve study strategies the ones they used and to rank their top five in order of personal preference. Repeated reading was the most frequently used strategy with 83.3% of students reporting that they used it and 43.9% naming it as their top strategy. Of these students, 45.5% indicated that they self-tested while studying, but none indicated it was their number one strategy. The second question asked students how they would study after reading a textbook chapter for the first time. They were asked to choose one option from three possibilities: going back and restudying, self-testing (with the possibility of restudying afterward), or some other strategy. On this question, 25.8% chose restudying, 45.5% chose self-testing, and 28.8% indicated they would use another study strategy. Thus, 54.6% of the students reported they would *not* test themselves after reading a textbook chapter. Of those who chose self-testing, only seven students indicated they would do so to improve learning. The results of this study suggest that the students lacked sufficient awareness of the superiority of self-testing for learning.

Dr. McAndrew is Clinical Professor and Senior Director of Professional Development, New York University College of Dentistry; Mr. Kamboj is a second-year dental student, New York University College of Dentistry; and Dr. Pierre is an independent research scientist consultant. Direct correspondence to Dr. Maureen McAndrew, New York University College of Dentistry, 345 East 24th Street, 8W, New York, NY 10010; 212-998-9333; mm154@nyu.edu.

Keywords: dental education, dental students, study strategies, academic performance, self-testing, retrieval practice, metacognition, self-regulated learning

Submitted for publication 4/25/14; accepted 6/20/14

A variety of studies have demonstrated that tests have direct effects on long-term retention of information.¹⁻⁵ The benefits occur whether tests or quizzes are given by the teacher in the classroom or students practice retrieval on their own. The act of retrieval of information (also referred to as “retrieval practice” or “practice in recall”) appears to reinforce memory of information. Roediger and Karpicke⁶ claim that when students self-test, they are not only encoding associations among items but also encoding the process to retrieve those items. Self-testing provides practice in activating these retrievals, whereas traditional rereading or studying does not. Therefore, students remember more by self-testing than if they had repeatedly studied the material for an equivalent amount of time. More difficult retrievals, provided they are successful, result in larger benefits.^{2,7} This technique is especially effective when testing is spaced out over time.^{2,4} Benefits are further enhanced by feedback, which helps students identify and correct gaps in their knowledge.^{2,5} Moreover, by engaging in self-testing, students replicate the testing condition so that they practice the very activity they will use on testing day.⁷

Most of these studies were conducted using tests of verbal ability; however, two studies have demonstrated that retrieval practice is efficacious for other types of learning such as skills-based and spatial learning.^{8,9} Karpicke and Blunt also discovered that retrieval practice was superior to rereading and concept mapping for learning scientific knowledge and for making inferences.¹ Clinical decision making is dependent on a broad scientific knowledge base and neuronal networks that allow fluent retrieval of that knowledge. Willingham states that critical thinking is “intertwined with domain knowledge” so that it is impossible to teach students how to think critically without adequate background knowledge and practice.¹⁰ Therefore, test-enhanced learning appears to be an effective way to bolster the clinical knowledge necessary for critical thinking in dental practice.

Most dental educators use tests primarily as means to assess learning and assign grades and not as tools to promote actual learning and understanding. To make matters worse, exams given in dental school are mostly multiple-choice or recognition-type exams. Recent research has revealed that

production-type exams, like short answer and essay, are superior for learning probably because the retrievals are more difficult and students are less likely to remember incorrect information from a “distractor” (i.e., incorrect) option in a multiple-choice question.^{11,12} Moreover, dental students have criticized the overreliance on multiple-choice exams in dental school.¹³ Dental students often operate in crisis mode, making decisions about what and how to study by concentrating on what is most pressing or due and not for long-term retention of information. To that end, students, especially lower performers, cram or “mass” their study sessions rather than distribute study sessions over time, which has been found to be more advantageous.¹⁴

Cognitive science researchers have conducted most of their experiments on the retrieval practice phenomenon in the controlled environment of the laboratory. Karpicke et al. were interested in learning how students study in the real world.¹⁵ They asked 177 high-achieving undergraduate students at the University of Washington to list their study strategies in a free report type question, and then they created a list of the most commonly identified study techniques. They were especially interested in determining whether students practice retrieval when they study on their own, but they found few students were employing this evidence-based technique. When undergraduates do test themselves, they tend to use this technique to diagnose what they do and do not know and rarely to improve memory. Indeed, Kornell and Bjork surveyed 472 college students in 2007 and found that only 18% quizzed themselves in order to enhance their learning.¹⁶ In 2011, Schmidmaier et al. studied a group of 80 medical students and found that they were largely unaware of the superiority of the testing effect in supporting retention of material.¹⁷

We hypothesized that predoctoral dental students, who are required to learn vast amounts of information and are more seasoned students, may use self-testing more frequently than undergraduate students. However, we presumed that dental students would lack awareness of the efficacy of different study strategies for learning. The aim of this study was thus to determine how second-year dental students at New York University College of Dentistry (NYUCD) approached studying and the types of study methods the students preferred. Most notably, this research attempted to see if the students utilized retrieval techniques when studying and were aware of its benefits.

Methods

This study received approval from NYU’s Institutional Review Board as exempted research. The study utilized a modified version of Karpicke et al.’s two-question survey instrument¹⁵ in order to examine dental students’ favored studying techniques.

Karpicke et al.’s first question was open-ended, asking undergraduate students to list their study strategies. Those researchers compiled the eleven most frequently listed responses (listed more than once across all student responses) and then had students rank order the strategies in terms of frequency of use. Our modification consisted of utilizing Karpicke et al.’s eleven responses plus one additional strategy—teaching—and asking the dental students to choose from among them. The students also had the option to list a technique not found on the list. The second question was a forced report question. Participants were told to imagine reading a textbook chapter for an exam. They were then instructed to choose one option out of three possible alternatives after reading the chapter one time: A) go back and restudy either the entire chapter or certain parts of the chapters; B) try to recall material from the chapter (with the possibility of restudying afterwards); or C) use some other study technique. They were also asked to explain the rationale for their choice.

Second-year students at NYUCD were chosen because of their heavy didactic course load. We emailed 360 dental students in their second year to invite them to participate in this study and give them details on accessing the Qualtrics survey. Two reminder emails were sent over the course of six weeks.

Results

Of the total 360 second-year dental students, 66 completed the survey for a response rate of 18.3%. For each of the study strategies listed in Karpicke et al.’s study,¹⁵ the dental students indicated whether they used the strategy and then were instructed to rank their top five study strategies.

Of the 12 study strategies listed on the survey, repeated reading was the most frequently used by these students, with 83.3% of respondents reporting using it and 43.9% reporting it was their number one strategy (Table 1). In contrast, 45.5% of the students indicated that they practiced recall (self-testing) while studying, although none reported that

Table 1. Percentages and numbers of dental students who reported using each study strategy and ranking it as #1 (n=66)

Study Strategy	Use Strategy		Ranked It As #1 Strategy		Mean Rank
	Percentage	Number	Percentage	Number	
1. Rereading notes or textbooks	83.3%	55	43.9%	29	1.9
2. Practicing problems	43.9%	29	7.6%	5	3.2
3. Using flash cards	9.1%	6	1.5%	1	3.3
4. Rewriting notes	48.5%	32	19.7%	13	2.3
5. Studying in groups	37.9%	25	3.0%	2	2.9
6. Memorizing	71.2%	47	4.5%	3	3.3
7. Teaching	21.2%	14	1.5%	1	3.6
8. Using mnemonic devices (patterns of letters, ideas, or associations that assist in remembering something)	25.8%	17	0	0	3.6
9. Making outlines	39.4%	26	12.1%	8	2.7
10. Practicing recall (self-testing)	45.5%	30	0	0	3.9
11. Highlighting important points	54.5%	36	3.0%	2	2.9
12. Thinking of real-life examples	25.8%	17	3.0%	2	3.5

practicing recall was their number one study strategy. Four strategies were reportedly used more frequently than practicing recall: repeated reading (83.3%), memorizing (71.2%), highlighting important points (54.5%), and rewriting notes (48.5%).

The percentages of these dental students who chose to restudy, self-test followed by restudying, or do something else after reading a textbook chapter are shown in Table 2. Among the respondents, 25.8% chose to restudy (option A), and 28.8% indicated they would use some other study technique (option C). Thus, 54.6% of the students reported that they would *not* want to test themselves after reading a textbook chapter. Among these students, 45.5% did choose self-testing followed by restudying (option B). However, only seven students indicated that they would test themselves to practice recall; another seven reported that they would self-test to get feedback on how well they learned the material.

We also compared the results for question one from Karpicke et al.'s study of undergraduate

students¹⁵ to our dental student sample (Table 3). The percentage of the dental students who reported rereading notes or texts was comparable to the undergraduates. However, these dental students were four times more likely to report employing self-testing and memorizing as strategies than the undergraduate students and were much less likely to employ flashcards. (It is important to note that the use of flashcards can be interpreted as self-testing even though students sometimes passively reread the information on the cards. However, in our study only 9% of the dental students selected flashcards as a study strategy.) The dental students were nine times more likely than the undergraduates to highlight important points and five times more likely to think of real-life examples.

On question two, comparing the dental students' responses to those of Karpicke et al.'s study of undergraduates¹⁵ showed that a comparable percentage of the two groups chose option B (42.1% undergraduates vs. 45.5% dental), indicating they would want to test themselves with the opportunity to go

Table 2. Percentages (and numbers) of dental students who chose restudy, self-test (with restudy), or something else as preferred study strategy for textbook chapter (n=66)

Imagine you are reading a textbook chapter for an upcoming exam. After you have read the chapter one time, would you rather	Overall	Test for Feedback	Test to Practice Recall
A. Go back and restudy either the entire chapter or certain parts of the chapter	25.8% (17)		
B. Try to recall material from the chapter (with the possibility of restudying afterward)	45.5% (30)	10.6% (7)	10.6% (7)
C. Use some other study technique	28.8% (19)		

back and reread afterward (Table 4). However, 30% of the undergraduates said they tested themselves to receive feedback about how well they learned and 2.6% to practice recall; by contrast, 10.6% of the dental students said they self-tested to receive feedback and another 10.6% to practice recall.

Discussion

Self-testing can profoundly enhance student learning. When students test themselves or are tested on material, they remember more in the long term than if they had repeatedly studied it. However, the vast majority of the second-year dental students in this study reported that they repeatedly read their notes or textbook while studying similar to Karpicke et al.'s¹⁵ findings in an undergraduate student population. Furthermore, repeated reading was the most

often-used study strategy among all listed strategies. Interestingly, almost half of the second-year dental students indicated that they did practice recall (self-testing) while studying compared to just 10.7% of the undergraduates. However, not one of the 66 dental students indicated that it was their preferred study strategy. Of those students who engaged in self-testing while studying, only seven reported that they did so to improve their learning and another seven to receive feedback about how well they learned. These results suggest that the second-year dental students were largely unaware of the merits of self-testing for learning.

Karpicke et al. proposed that students may experience “illusions of competence” while rereading because of the relative ease of this technique.¹⁵ Because the information is right in front of the student, students may believe that they know more than they actually do. Unlike rereading, retrieval practice

Table 3. Comparison of results of undergraduate students and dental students on question 1

Study Strategy	% Who Used Strategy		% Who Ranked Strategy #1	
	Undergraduates	Dental Students	Undergraduates	Dental Students
1. Rereading notes or textbooks	83.6%	83.3%	54.8%	43.9%
2. Practicing problems	42.9%	43.9%	12.4%	7.6%
3. Using flash cards	40.1%	9.1%	6.2%	1.5%
4. Rewriting notes	29.9%	48.5%	12.4%	19.7%
5. Studying in groups	26.5%	37.9%	0.5%	3%
6. Memorizing	18.6%	71.2%	5.6%	4.5%
7. Teaching	0	21.2%	0	1.5%
8. Using mnemonic devices	13.5%	25.8%	2.8%	0
9. Making outlines	12.9%	39.4%	3.9%	12.1%
10. Practicing recall techniques (self-testing)	10.7%	45.5%	1.1%	0
11. Highlighting important points	6.2%	54.5%	1.6%	3%
12. Thinking of real-life examples	4.5%	25.8%	0.5%	3%

Note: Participants in the reported studies were 177 undergraduate students at Washington University in St. Louis (Karpicke et al. study) and 66 second-year dental students at New York University.

Table 4. Comparison of undergraduates' to dental students' responses on question 2

After you have read the chapter once, would you rather	Undergraduate Students	Dental Students
A. Go back and restudy either the entire chapter or certain parts of the chapter	40.8%	25.8%
B. Try to recall material from the chapter (with the possibility of restudying afterward), as well as:	42.1%	45.5%
1. Test for feedback	30.3%	10.6%
2. Test to practice recall	2.6%	10.6%
C. Use some other study technique	17.1%	28.8%

Note: Participants in the reported studies were 76 undergraduate students at Washington University in St. Louis (Karpicke et al. study) and 66 second-year dental students at New York University.

often requires considerable effort. Because it can be so mentally taxing and difficult, students may avoid the exercise to their detriment. Studies have found that when self-testing was utilized, it was more often motivated by a desire to diagnose learning deficiencies than to improve learning.^{5,18} Similarly, our findings indicate that of those dental students who do practice retrieval, only seven did so to learn better.

This study has some limitations including the low response rate and a relatively small sample size. Furthermore, since this study was conducted at one dental school, the results may not be generalizable to all dental students.

Conclusion

The results of this study suggest that many second-year dental students may be unaware of the powerful effect of retrieval practice or self-testing and instead prefer to spend their study sessions rereading material. When the dental students in this study did self-test, they did it to diagnose knowledge gaps and rarely as a means to learn. These findings, along with other research in cognitive science, will be used to educate NYU dental students and faculty on the most efficient techniques that boost learning and show potential to improve academic performance. These results may motivate dental educators to incorporate frequent quizzing into their courses, give students feedback on correct answers after a short delay, give more tests that require constructed responses (like short-answer and essay), and encourage their students to employ self-testing when they study on their own and to refrain from massed study sessions or cramming. Faculty development on the neurobiology of learning and assessment may be necessary to expedite such changes in teaching methodologies. Because an extensive knowledge base is requisite for diagnostic reasoning and clinical performance, improving retention of relevant material by using self-testing and other evidence-based techniques is imperative at all junctures in one's dental education, from the student's first year in dental school to the last year of dental practice.

Acknowledgments

The authors would like to thank Drs. Jeffrey D. Karpicke, Andrew C. Butler, and Henry L. Roediger III for the use of their survey instrument and for their kind advice.

REFERENCES

1. Karpicke JD, Blunt JR. Retrieval practice produces more learning than elaborative studying with concept mapping. *Science* 2011;331(6018):772-5.
2. Larsen DP, Butler AC, Roediger HL III. Repeated testing improves long-term retention relative to repeated study: a randomized controlled trial. *Med Educ* 2009;43(12):1174-81.
3. McDaniel MA, Anderson JL, Derbish MH, Morrisette N. Testing the testing effect in the classroom. *Eur J Cogn Psychol* 2007;19(4-5):494-513.
4. Roediger HL, Karpicke JD. Test-enhanced learning taking memory tests improves long-term retention. *Psychol Sci* 2006;17(3):249-55.
5. Roediger HL III, Butler AC. The critical role of retrieval practice in long-term retention. *Trends Cogn Sci* 2011;15(1):20-7.
6. Roediger HL, Karpicke JD. The power of testing memory: basic research and implications for educational practice. *Perspect Psychol Sci* 2006;1(3):181-210.
7. Larsen DP, Butler AC, Roediger HL III. Test-enhanced learning in medical education. *Med Educ* 2008;42(10):959-66.
8. Kromann CB, Jensen ML, Ringsted C. The effect of testing on skills learning. *Med Educ* 2009;43(1):21-7.
9. Carpenter SK. Testing enhances the transfer of learning. *Curr Dir Psychol Sci* 2012;21(5):279-83.
10. Willingham DT. Critical thinking. *Am Educator* 2007;31(2):8-19.
11. Pinckard RN, McMahan CA, Prihoda TJ, et al. Short-answer examinations improve student performance in an oral and maxillofacial pathology course. *J Dent Educ* 2009;73(8):950-61.
12. Roediger HL III, Marsh EJ. The positive and negative consequences of multiple-choice testing. *J Exp Psychol Learn Mem Cogn* 2005;31(5):1155.
13. Henzi D, Davis E, Jasinevicius R, Hendricson W. In the students' own words: what are the strengths and weaknesses of the dental school curriculum? *J Dent Educ* 2007;71(5):632-45.
14. Cepeda NJ, Pashler H, Vul E, et al. Distributed practice in verbal recall tasks: a review and quantitative synthesis. *Psychol Bull* 2006;132(3):354.
15. Karpicke JD, Butler AC, Roediger HL III. Metacognitive strategies in student learning: do students practice retrieval when they study on their own? *Memory* 2009;17(4):471-9.
16. Kornell N, Bjork RA. The promise and perils of self-regulated study. *Psychonomic Bull Rev* 2007;14(2):219-24.
17. Schmidmaier R, Ebersbach R, Schiller M, et al. Using electronic flashcards to promote learning in medical students: retesting versus restudying. *Med Educ* 2011;45(11):1101-10.
18. Kornell N, Son LK. Learners' choices and beliefs about self-testing. *Memory* 2009;17(5):493-501.