THE TEACHING
ECONOMIST

Issue 50, Spring 2016 William A. McEachern, Editor

"But I Studied Hard..."

We have all faced frustrated students after that first exam. They tell us they "studied hard." They came to class, took notes, read the textbook, and highlighted key passages. They even reread class notes and the text until the material became thoroughly familiar. "How could all this time and effort result in a C? It's so unfair!"

Here are some questions to ask such students. During class, did they note key concepts and summarize the main points. Did they ask questions of you in class or perhaps write down a few questions for later review. While reading class notes or the textbook, did they try summarizing key points in their own words and pose some questions to test themselves later? How frequently did they try to recall the material by quizzing themselves on it? Did they try to relate new material to what they had already learned? Did they ever look for examples of key concepts outside the text and lectures?

The problem is that most students don't really know how to study. More than 80 percent of college students believe that rereading the textbook and class notes is the path to learning. But simply rereading material is usually a labor in vain because (1) it's time consuming; (2) it's usually passive, not active; (3) it does not result in durable learning and (4), even worse, it promotes a kind of self-deception, as a growing familiarity from rereading comes to feel like mastery of the material. The hours spent rereading material seem like time well spent, but study time alone is not a reliable gauge of learning.

Regular readers of this newsletter will recognize some of this, as I have been underscoring relevant research for 25 years in *The Teaching Economist*. In this, my 50th issue, I want to discuss why many students become frustrated with their test results. I'll draw on recent research in cognitive science, especially the new book *Make It Stick: The Science of Successful Learning* from Harvard University Press by cognitive psychologists Henry L. Roediger III and Mark A. McDaniel and "storyteller" Peter C. Brown. I'll focus on what for many students is the missing link in the learning process—retrieving material from memory.

Retrieval: The Key to Learning

Though cognitive science remains a work in progress, with some questions far from settled, decades of experiments have yielded important findings about teaching and learning. First, let me set the table. The primary goal of education is to generate learning that is durable, flexible, and transferable in a generalized way to new situations. Cognitive scientists believe that we learn by focusing on the relevant material, organizing it into a coherent mental structure, integrating it with our prior knowledge, *retrieving that new knowledge from memory*, then applying that knowledge to a new situation. All this seems straightforward enough, but dozens of laboratory experiments find that instructors and students alike are easily misled about what works and what doesn't. For example, measures that introduce difficulties for learners in the short term seem to aid long-term learning and transfer.

Rather than rereading the textbook or class notes, better that the student should first try to recall that material from memory both to strengthen that mental connection and to discover gaps that warrant more attention. Tests, quizzes, self-tests, and other retrieval efforts help encode new material into long-term memory and identify what still needs work. Dozens of studies back this up. For example, a study in *Science* (1/20/2011) compared the performance of students who read and reread text material four times with students who read the text, closed the book, tried to write down all they could retrieve from memory, then did that again, spending the same total time as the first group. Students in this second group were, in effect, testing their knowledge of what they had read. All students were then asked to predict how well they would do on a test of the material a week hence. Those who did not try to retrieve the material expected a score about 40% higher than did those who did try to retrieved the material. A week later, all students were tested with some questions drawn verbatim from the material and others requiring inferences about how concepts related. The retrievers averaged about 40% higher than the readers on both types of questions.

What explains the superiority of retrieval? Retrieval is not simply a readout of material that has been stored in memory. Cognitive scientists believe that the process of trying to recall information creates new learning pathways in the brain, making that information more accessible in the future. The mind is practicing what it needs to do in the future to recall that information. And the struggle to retrieve material makes the link that much stronger. But the very struggle that helps us recall something also makes us feel like we're not learning much, so retrieval seems less productive to us. Our reaction after retrieval efforts might be, "I realize I don't know the material that well, and it's harder than I thought, so I should review those parts again." We have the opposite reaction after simply

rereading material. Our reaction might be, "Oh yes, this is familiar. I've got this." Intuition gives us the wrong idea about how best to learn and remember.

What are some practical implications of this for your class? As retrieval aids, tests, quizzes, including self-tests of recall, such as questions posed while reading, flash cards, and quizzing software, are more effective than simply rereading material. Ask students questions frequently during class. And give them time to retrieve the answers. Encourage students to quiz themselves and one another in study sessions. A test or quiz amounts to forced retrieval, and this, in itself, helps students learn and remember.

Most students don't like taking tests or quizzes and most instructors don't like preparing, administering, and grading them. So such retrieval is usually not a valued activity in itself. *But tests and frequent, low-stakes, classroom quizzes are effective ways of helping students learn new material.* Try giving short quizzes at the end of class covering the material from that day and recent days. Intervening tests help subsequent test performance, and mixing up the type of test seems to help students with later retrieval.

Again, the familiarity that comes from rereading text or notes conveys a false sense of mastery. This deception is true for all of us in all aspects of our lives. For example, you have been looking at maps of the United States all your life, hundreds or even thousands of time, such as national weather maps and electoral maps. Surely you could fill in the state names on a map outlining state boundaries. Prove it! Go online and print out a blank map outlining the states. Now try filling in the names. Go ahead. See if you can.

We are all lifelong learners, or at least we should be. According to an Indonesian proverb, "Learning from a teacher who has stopped learning is like drinking from a stagnant pool." Learning is an acquired skill. Anyone who becomes a more efficient learner gains a lifelong advantage.

Spacing

Because new learning depends on prior learning, by spacing study sessions, the student lays a foundation for subsequent learning. Students should space out studying and self-testing over multiple points of time. This may sound crazy, but such spacing helps because it provides some time during which some forgetting can occur. Spacing out studying, as opposed to massed studying, or cramming, feels less productive because some forgetting has set in and the student must work harder to recall the concepts. It doesn't feel much like learning. But that extra effort makes learning more durable. The more often students retrieve partially forgotten concepts, the more easily and completely these concepts can be retrieved in the future. Spacing retrieval helps embed learning in long-term memory. In fact, *the near-term and long-term benefit of spacing out study sessions is one of the most robust findings in the history of experimental research on learning and memory.*

The opposite of spacing is massed study, or cramming, which has been compared to binge and purge eating. Much goes in, but most of that comes right back out. Again, spacing study sessions makes learning more durable. What's a minimum interval for spacing? Long enough so that a little forgetting has set in. If the interval is so short that nothing much has been forgotten, the retrieval process becomes more like rote repetition. But the interval between sessions should not be so long that material must be relearned all over again. Sleep seems to help with learning consolidation, so space studying with at least a night's sleep between sessions. I have likened the spacing process to how a 3-D printer creates a layer at a time. Each layer builds on the previous layer, and each layer needs time to set. Likewise the material in a course is learned a layer at time over days, weeks, and months. A course cannot be absorbed during an all-nighter. Student retrieval helps "set" each layer as the term progresses.

Begin class with a five-minute summary including questions about key points covered in the previous two or three classes, then use that as a bridge to new material. Give students a short break during class to summarize main points in their own words. Research shows that students asked to summarize class material during four-minute breaks during class later demonstrated more comprehension than other groups of students. Your presentations and exams should be cumulative to ensure that students build layers of learning during the term.

Be Transparent

Because much of this is counterintuitive, you should try to explain to students how learning works, particularly the importance of retrieval. To help students manage their own education, explain what research has revealed. Be up front about some of the frustrations and difficulties real learning entails and explain why it's worth persisting. Challenges that may slow down students in the short run seem to benefit long-term learning. For example, if students stop and quiz themselves as they read and develop questions for later review, that takes longer and can be frustrating, but it pays off. Students should understand that when learning is hard, they are doing important work. They are rewiring their brains.

Your course should not be some giant Easter-egg hunt. Your goals should be clear. Students should be able to see right through you. Tell them what you are doing and why. Your syllabus should be clear, with weights and dates of all assignments. If you don't want to get hammered on your student evaluations, make sure students know what to expect in your course. Nobody likes surprises (students hate pop quizzes).

As your teaching becomes more transparent, students will grow to appreciate the rationale behind your methods, such as your use of frequent quizzes. Students may also come to realize that learning is supposed to be challenging and difficult. If learning were easy for students, then teaching would be easy for you. Try to nudge your students' study efforts in a more productive direction.

In an extensive literature survey, **Sam Allgood** and **William B. Walstad**, both of the University of Nebraska at Lincoln, and **John J. Siegfried** of Vanderbilt organize and summarize a wide range of research about teaching economics to undergraduates. A similar survey appeared about two decades ago and serves as a reference point. In a few words, I'll summarize each of 12 topics addressed in the survey. The authors review the status of economic instruction—such as (1) *numbers and trends* (about 40% of undergraduates take at least one economics course; economics majors nearly doubled over the last two decades; and the economics major is more popular now than other quantitative disciplines such as math, statistics, chemistry, and physics), (2) *instructional goals* (teaching students to think like economists), (3) *trends in courses* (less money and banking, more econometrics), and (4) *student outcomes* (economics graduates appear satisfied with their major and their job opportunities). The authors also review empirical findings on a range of topics including (5) *teaching methods* (innovative approaches are discussed more than implemented), (6) *online technology* (face-to-face classes still seem best for learning, but experiments and homework can be carried out efficiently online), and (7) *class size* (students benefit from smaller classes). Studies of student learning are examined in relation to (8) *study time* (which is down), (9) *grades* (which are up), (10) *class attendance* (which should augment, not displace, study time), (11) *math aptitude* (helps with economics), and (12) *cheating* (should be controlled with surveillance and detection). The authors also develop a theoretical model examining optimal strategies by instructors and students. I have merely skimmed a survey that references nearly 200 studies and fills 41 double-columned pages. See "Research on Teaching Economics to Undergraduates," *Journal of Economic Literature*, 53 (June 2015): 285-325.

What's the impact of labor market conditions on the choice of a college major? **Mark C. Long**, of Washington University, **Dan Goldhaber** of the Center for Education Data and Research, and **Nick Huntington-Klein** of California State University at Fullerton find statistically significant relationships between changes in wages by occupation and subsequent changes in college majors completed in relevant fields between 1982 and 2012. College majors are strongly related to wages observed three years earlier, when students were college freshmen. The response to wages varies, depending on the extent to which there is a strong link between majors and particular occupations. The authors note that women, blacks, Hispanics, and students with low test scores are less likely to respond to wage changes. See "Do Completed College Majors Respond to Changes in Wages?" *Economics of Education Review*, 49 (December 2015): 1-14.

Why are students who enroll in a two-year college much less likely to ultimately graduate from a four-year college than are similarly capable students who enroll in a four-year college? **Jonathan Smith** of the College Board and **Kevin Stange** of the University of Michigan investigate the impact of peer quality on graduation rates based on a sample of over three million high school graduates. The authors draw on data from all PSAT test-takers between 2004 and 2006. They find that half the gap in bachelor's degree attainment rates between students who start at two-year versus four-year institutions is explained by differences in peers at their institutions. Difficulty transferring from two- to four-year institutions also plays a role. Having capable peers is associated with higher attainment in both two-year and four-year institutions, but that effect is quite a bit larger in four-year institutions. Incidentally, enrollment shifts from four-year to two-year colleges help explain a large share of the decline in college completion rates between 1972 and 1992. See "A New Measure of College Quality to Study the Effects of College Sector and Peers on Degree Attainment," which is forthcoming in *Education Finance and Policy*, a new journal this year from MIT.

Using a large survey of first-year and final-year students from different disciplines, **Amelie Goosens** and **Pierre-Gaillaume Meon**, both of the Free University of Brussels, explore the belief in the mutual gains from market transactions. They find that economics and business students are much more inclined to believe in such gains than are students from other disciplines. What's more, the belief gap between the two groups increases between the first and final year, in part because economics students increasingly support that belief and in part because other students, particularly those in psychology, increasingly fail to believe in such gains. And the beliefs of economics students become more homogeneous by their final year. The authors find both a self-selective effect at the outset among majors and a reinforcing effect within disciplines that goes beyond initial self-selection. See "The Belief that Market Transactions are Mutually Beneficial: A Comparison of the Views of Students in Economics and Other Disciplines," *Journal of Economic Education*, 46 (Issue 2, 2015): 121-134.

Because of an administrative glitch, random students were able to see their course grades prior to their evaluations of instructors. **Donghun Cho** of Hallym University in Korea and **Wonyoung Baek** and **Joonmo Cho** of Sungkyunkwan University in Korea viewed this as a chance to see how knowledge of actual grades affects student evaluations. As it turned out, students receiving grades that exceeded their expectations gave higher teacher evaluations, whereas students receiving grades below their expectations gave lower teacher evaluations. See "Why Do Good Performing Students Highly Rate Their Instructors? Evidence from a Natural Experiment," *Economics of Education Review*, 49 (December 2015): 172-179.

Do classroom experiments mean more if students play for real money? Using 641 principles of economics students across four universities, **Matthew Rousu** of Susquehanna University and eight coauthors wanted to see if providing cash incentives in a prisoner's dilemma game would boost student learning. Subjects either (1) played a prisoner's dilemma game for real money, (2) played the same game for no money, or (3) were in a control group where no game was played. Students who played the classroom game for real money had significantly higher test scores on that material than students who played the hypothetical game or played no game (there was no test score difference between those playing a hypothetical game and those playing no game). These findings challenge the conventional wisdom that monetary incentives are unnecessary in classroom experiments. See "Do Monetary Incentives Matter in Classroom Experiments? Effects on Course Performance," *Journal of Economic Education*, 46 (Issue 4, 2015): 341-349. A prepublication copy of the paper is available at http://economics.kenyon.edu/corrigan/publications/Do%20Monetary%20Incentives%20Matter%20in%20Classroom%20Experiments.pdf.

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Odds and Ends

During the 25 years of *The Teaching Economist*, I have included more than a hundred quotes at the end of this "Odds and Ends" section. Here are some of my favorites:

▼ "Tell me and I forget, teach me and I remember, involve me and I learn."
—Ben Franklin

▼ "The aim of all education is, or should be, to teach people to educate themselves."
—Arnold Toynbee

▼ "Education is not the filling of a pail, but the lighting of a fire."
—William Butler Yates

▼ "That is what learning is. You suddenly understand something you have understood your whole life, but in a new way."
—Doris Lessing

▼ "The real act of discovery consists not in finding new lands but in seeing with new eyes."
— Marcel Proust

▼ "The highest result of education is tolerance."
—Helen Keller

▼ "To know truly is to know by cause."
—Francis Bacon

▼ "A generous and elevated mind is distinguished by nothing more certainly than an eminent degree of curiosity."
—Samuel Johnson

▼ "One of the greatest pains to human nature is the pain of a new idea."
—Walter Bagehot

▼ "Every thinker puts some portion of an apparently stable world in peril."
— John Dewey

▼ "The man with a new idea is a crank until the idea succeeds."
—Mark Twain

▼ "Judge a man by his questions rather than his answers."
—Voltaire

▼ "If one cannot state a matter clearly enough so that even an intelligent twelve-year old can understand it, one should remain in the cloistered walls of the university and laboratory until one gets a better grasp of one's subject matter."
— Margaret Mead

▼ "Some experience of popular lecturing had convinced me that the necessity of making things plain to uninstructed people was one of the very best means of clearing up the obscure corners in one's own mind."
—T. H. Huxley

▼ "It is by teaching that we teach ourselves, by relating that we observe, by affirming that we examine, by showing that we look, by writing that we think, by pumping that we draw water into the well."
—Henri-Frédéric Amiel

▼ "The Universe is full of magical things, patiently waiting for our wits to grow sharper."
—Eden Phillpotts

▼ "When the student is ready, the teacher appears."
—Chinese proverb

Ideas for the Grapevine

If you have developed any attention-getting examples, ways to "sensationalize" economic ideas, useful online resources, or more generally, ways to teach just for the fun of it, please share these with colleagues in "The Grapevine" by sending them to:

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