WHAT WORKS, WHAT DOESN’T

Some study techniques accelerate learning, whereas others are just a waste of time—but which ones are which? An unprecedented review maps out the best pathways to knowledge.

BY JOHN DUNLOSKY, KATHERINE A. RAWSON, ELIZABETH J. MARSH, MITCHELL J. NATHAN AND DANIEL T. WILLINGHAM

ILLUSTRATIONS BY CELIA JOHNSON
Education generally focuses on what you study, such as algebra, the elements of the periodic table or how to conjugate verbs. But learning how to study can be just as important, with lifelong benefits. It can teach you to pick up knowledge faster and more efficiently and allow you to retain information for years rather than days.

Cognitive and educational psychologists have developed and evaluated numerous techniques, ranging from rereading to summarizing to self-testing, for more than 100 years. Some common strategies markedly improve student achievement, whereas others are time-consuming and ineffective. Yet this information is not making its way into the classroom. Teachers today are not being told which learning techniques are supported by experimental evidence, and students are not being taught how to use the ones that work well. In fact, the two study aids that students rely on the most are not effective. One of them may even undermine success.

One potential reason is that the huge amount of research is overwhelming, making it difficult for educators and students to identify the most practical and advantageous ways to study. To meet this challenge, we reviewed more than 700 scientific articles on commonly used learning techniques. We focused on strategies that seem to be easy to use and broadly effective. We also took a closer look at a couple of methods that are very popular with students.

To receive our recommendation, a technique must be useful in a range of learning conditions, such as whether a student works alone or in a group. It must assist learners of various ages, abilities and levels of prior knowledge—and it must have been tested in a classroom or other real-world situation.

HOW IT WORKS: Unlike a test that evaluates knowledge, practice tests are done by students on their own, outside of class. Methods might include using flash cards (physical or digital) to test recall or answering the sample questions at the end of a textbook chapter. Although most students prefer to take as few tests as possible, hundreds of experiments show that self-testing improves learning and retention.

In one study, undergraduates were asked to memorize word pairs, half of which were then included on a recall test. One week later the students remembered 35 percent of the word pairs they had been tested on, compared with only 4 percent of those they had not. In another demonstration, undergraduates were presented with Swahili-English word pairs, followed by either practice testing or review. Recall for items they had been repeatedly tested on was 80 percent, compared with only 36 percent for items they had studied. One theory is that practice testing triggers a mental search of long-term memory that activates related information, forming multiple memory pathways that make the information easier to access.

WHEN DOES IT WORK?: Anyone from preschoolers to fourth-year medical students to middle-age adults can benefit from practice testing. It can be used for all kinds of factual information, including learning words in foreign languages, making spelling lists and memorizing the parts of flowers. It even improves retention for people with Alzheimer’s disease. Short, frequent exams are most effective, especially when test takers receive feedback on the correct answers.

Practice testing works even when its format is different from that of the real test. The beneficial effects may last for months to years—great news, given that durable learning is so important.

IS IT PRACTICAL?: Yes. It requires modest amounts of time and little to no training.

HOW CAN I DO IT?: Students can self-test with flash cards or by using the Cornell system: during in-class note taking, make a column on one side of the page where you enter key terms or questions. You can test yourself later by covering the notes and answering the questions (or explaining the keywords) on the other side.

RATING: High utility. Practice testing works across an impressive range of formats, content, learner ages and retention intervals.

WE REVIEWED MORE THAN 700 SCIENTIFIC ARTICLES ON 10 COMMON LEARNING TECHNIQUES TO IDENTIFY THE MOST ADVANTAGEOUS WAYS TO STUDY.
studies involving more than 14,000 participants, students recalled more after spaced study (scoring 47 percent overall) than after massed study (37 percent).

WHEN DOES IT WORK? Children as young as age three benefit, as do undergraduates and older adults. Distributed practice is effective for learning foreign vocabulary, word definitions, and even skills such as mathematics, music and surgery.

IS IT PRACTICAL? Yes. Although textbooks usually group problems together by topic, you can intersperse them on your own. You will have to plan ahead and overcome the common student tendency to procrastinate.

HOW CAN I DO IT? Longer intervals are generally more effective. In one study, 30-day delays improved performance more than lags of just one day. In an Internet-based study of trivia learning, peak performance came when sessions were spaced at about 10 to 20 percent of the retention interval. To remember something for one week, learning episodes should be 12 to 24 hours apart; to remember something for five years, they should be spaced six to 12 months apart. Although it may not seem like it, you actually do retain information even during these long intervals, and you quickly relearn what you have forgotten. Long delays between study periods are ideal to retain fundamental concepts that form the basis for advanced knowledge.

RATING: High utility. Distributed practice is effective for learners of different ages studying a wide variety of materials and over long delays. It is easy to do and has been used successfully in a number of real-world classroom studies.

THE RUNNERS-UP

Despite their promise, the following learning techniques fall short, in many cases because not enough evidence has been amassed to support their use. Some techniques, such as elaborative interrogation and self-explanation, have not been evaluated sufficiently in real-world educational contexts. Another emerging method called interleaved practice has just begun to be systematically explored. Nevertheless, these techniques show enough potential for us to recommend their use in the situations described briefly here.

3. ELABORATIVE INTERROGATION

Channel Your Inner Four-Year-Old

Elaborative interrogation, learners produce explanations for facts, such as “Why does it make sense that...?” or “Why is this true?” In one experiment, for example, students read sentences such as “the hungry man got into the car.” Participants in an elaborative interrogation group were asked to explain why, whereas others were provided with an explanation, such as “the hungry man got into the car to go to the restaurant.” A third group simply read each sentence. When asked to recall which man performed what action (“Who got in the car?”), the elaborative-interrogation group answered about 72 percent correctly, compared with about 37 percent for the others.

HOW IT WORKS: Inquisitive by nature, we are always looking for explanations for the world around us. A sizable body of evidence suggests that prompting students to answer “Why?” questions also facilitates learning.

PROMPTING STUDENTS TO ANSWER “WHY?” QUESTIONS, CALLED ELABORATIVE INTERROGATION, ALSO FACILITATES LEARNING.

(The Authors)

JOHN DUNLOSKY is professor of psychology at Kent State University. KATHERINE A. RAWSON is associate professor of psychology at Kent State. ELIZABETH J. MARSH is associate professor of psychology and neuroscience at Duke University. MITCHELL J. NATHAN is professor of psychology, educational psychology, and curriculum and instruction at the University of Wisconsin–Madison. DANIEL T. WILLINGHAM is professor of psychology at the University of Virginia.

4. SELF-EXPLANATION

How Do I Know?

The effects of this technique appear to be robust across ages, from fourth graders through undergraduates. Elaborative interrogation clearly improves memory for facts, but whether it also might enhance comprehension is less certain, and there is no conclusive information about how long the gains in learning persist.

IS IT PRACTICAL? Yes. It requires minimal training and makes reasonable time demands. In one study, an elaborative-interrogation group required 32 minutes to do a task that took 28 minutes for a reading-only group.

RATING: Moderate utility. The technique works for a broad range of topics but may not be useful for material more complex than a factual list. Benefits for learners without prior knowledge may be limited. More research is needed to establish whether elaborative interrogation generalizes to various situations and different types of information.

5. INTERLEAVED PRACTICE

Mixing Apples and Oranges

HOW IT WORKS: Students tend to study in blocks, finishing one topic or type of problem before moving on to the next. But recent research has shown benefits for interleaved practice, in which students alternate a variety of types of information. In one study, for example, college students learned to compute the volumes of four different geometric shapes. In a so-called blocked-practice condition, they finished all the problems for one shape before moving on to the next. In interleaved practice, the problems were intermixed. When tested one week later, the interleaved
What Doesn’t Work

These techniques were rated as low utility because they are inefficient, ineffective or beneficial only for certain types of learning and for short periods of retention. Most students report rereading and highlighting, yet those techniques do not consistently boost performance, and they distract students from more productive strategies. Other methods mentioned below are just too time-consuming.

WHAT SHOULD YOU DO INSTEAD: Don’t waste your time—in head-to-head comparisons, rereading fares poorly against more active strategies such as elaborative interrogation, self-explanation and practice testing.

Three less commonly used study techniques also fared poorly in our assessment. “Imagery for text learning” needs more evidence before it can be recommended, whereas “summarization” and “keyword mnemonic” appear to be inefficient and time-consuming. In summarization, students identify a text’s main points, excluding unimportant material. Whether it works is difficult to answer, as it has been implemented in many different ways. It is unknown whether summarizing small pieces of a text or large chunks of it works better or whether the length, readability or organization of a material matters.

Keywords and mnemonics, imagery is used to enhance memory; for example, a student studying the French word la dent (“tooth”) might use the similar sounding English word “dentist” to form a mental image of a dentist holding a large molar. Mnemonics do seem to help with foreign-language vocabulary, word definitions and medical terminology, but the effects have not been shown to endure, and in the end the effort involved in generating keywords may not be an efficient use of time.

Another technique that uses mental pictures is imagery for text learning, in which students are told to create images for every paragraph they read. Research has revealed a patchwork of inconsistent results that have not been shown to last over the long term. Teachers may consider instructing students to attempt using this technique with image-friendly texts, but further demonstrations of its usefulness are needed.

See the Psychological Science in the Public Interest article “Improving Students’ Learning with Effective Learning Techniques: Promising Directions from Cognitive and Educational Psychology,” on which this story for Scientific American Mind is based, at the Association for Psychological Science’s Web site: www.psychologicalscience.org

STUDENTS ARE NOT USING THE BEST STRATEGIES, PERHAPS BECAUSE TEACHERS THEMSELVES ARE NOT SCHOoled IN THEM.

What We Have Learned

Why don’t students use more effective study techniques? It seems they are not being taught the best strategies, perhaps because teachers themselves are not schooled in them. In our survey of six educational psychology textbooks, only one technique—“keyword mnemonics”—was covered in every book. None offered much guidance on the use, effectiveness or limitations of different ways of studying.

A second problem may be that in the educational system, the emphasis is on teaching students critical-thinking skills and content. Less time is spent on teaching them how to learn. The result can be that students who do well in their early years, when learning is closely supervised, may struggle once they are expected to regulate their own learning in high school or college.

Some questions, such as the best age for students to start using a technique and how often they will need to be re-trained or reminded, still require further research. But even now teachers can incorporate the most successful approaches into lesson plans, which students could adopt on their own. For instance, when moving to a new section, a teacher can start by asking students to do a practice test that covers important ideas from the previous section and providing immediate feedback. Students can interleave new problems with related ones from preceding units. Teachers can harness distributed practice by reintroducing major concepts during the course of several classes. They can engage students in explanatory questioning by prompting them to consider how the information is new to them or why it might be true.

These learning techniques are not panaceas. They benefit only those who are motivated and capable of using them. Nevertheless, we expect that students will make meaningful gains in classroom performance, on achievement tests and during their lifetime. M

(To be continued in part 2)

(Further Reading)


- 52 SCIENTIFIC AMERICAN MIND © 2013 Scientific American

- Mind.ScientificAmerican.com © 2013 Scientific American

- SCIENTIFIC AMERICAN MIND 33