

2. When Students Study On Their Own, What Works and What Doesn't?

In this extraordinarily thorough 54-page monograph in *Psychological Science in the Public Interest*, John Dunlosky and Katherine Rawson (Kent State University), Elizabeth Marsh (Duke University), Mitchell Nathan (University of Wisconsin/Madison), and Daniel Willingham (University of Virginia) report on their review of the effectiveness of ten different study techniques that students use for independent study. Each is a plausible method for improving achievement and several are very common – but only two are highly effective and three moderately effective. Here is the authors' overall assessment of each one, with details on how generalizable the technique proved to be in research studies:

1. Re-reading – Going over text material two or more times after an initial reading is one of the most widely used study techniques.

- *Overall assessment* – **Low utility**
- *Impact in different learning conditions* – One key variable is the amount of time between initial reading and rereading, with a longer lag-time producing better learning.
- *Impact with different students* – Almost all studies of rereading have been done on college students, so we don't know much about K-12 applications.
- *Impact with different learning materials* – Researchers have looked at the effect of rereading across a variety of school materials.
- *Impact with different ways of measuring student learning* – Studies have not shown robust learning gains in various kinds of assessments.
- *Effects in representative educational contexts* – Rigorous research on this technique in different classroom settings is virtually non-existent.
- *Implementation issues* – Students need no training to use this strategy except knowing to wait a little while after initial reading before rereading.

2. Highlighting and underlining – Marking potentially important portions of to-be-learned materials while reading; this technique is widely used by students at all levels.

- *Overall assessment* – **Low utility**
- *Impact in different learning conditions* – Research has found this technique to be unproductive in a wide variety of classroom settings.
- *Impact with different students* – Studies have found highlighting and underlining to be ineffective with students from the primary grades to Air Force basic trainees. The problem is that students often don't highlight the most important material or over-highlight so they can't see the forest for the trees.
- *Impact with different learning materials* – With difficult material, highlighting and underlining may actually hurt students' performance on higher-level tasks that require inferential thinking.
- *Impact with different ways of measuring student learning* – Research shows weak results.

- *Effects in representative educational contexts* – Several studies found that when teachers highlighted important parts of texts, students did better on assessments, but this did not put highlighting into the front ranks of effectiveness.
- *Implementation issues* – Students often highlight in ways that are not helpful to learning, and the time spent highlighting is time not spent on more-effective techniques. Extensive training can improve students' skill at highlighting the most important material, but this is time-consuming and detracts from other approaches that would be more productive.

3. Summarization – Writing summaries of to-be-learned material, capturing the gist and not unimportant or repetitive material:

- *Overall assessment* – **Low utility**
- *Impact in different learning conditions* – The key question is whether students have the material in front of them while they summarize or put the text aside and test their memory. The research is mixed on both conditions.
- *Impact with different students* – Most of the research has been on college students; younger students have difficulty writing accurate summaries and this makes the technique less effective for them.
- *Impact with different learning materials* – Most studies have looked at students' summarizing of prose passages, and more research is needed on other types of materials.
- *Impact with different ways of measuring student learning* – The research here is mixed, with some studies showing benefits to long-term learning and others showing students performing worse.
- *Effects in representative educational contexts* – The concern here is whether students have learned to accurately summarize material.
- *Implementation issues* – This technique is relatively easy for students who know how to summarize, but for those who don't, extensive training is required.

4. Keyword mnemonic – Using keywords and mental imagery (visualizing the material to be learned in your “mind's eye”) to associate and remember material; this time-honored technique has been studied since the late 1800s. An example: to learn the French word *la dent* (tooth), the student thinks of an English word that will be helpful (dentist) and forms a mental image of a dentist holding a large molar with a pair of pliers.

- *Overall assessment* – **Low utility**
- *Impact in different learning conditions* – Researchers have found that this technique is widely used and appears to help students remember the studied material. However, other techniques work better.
- *Impact with different students* – Studies have covered numerous ages and types of students using this approach.

- *Impact with different learning materials* – Researchers have looked at numerous subject areas and types of materials, and many don't lend themselves to the easy association of *la dent* with dentist.
- *Impact with different ways of measuring student learning* – Although using keywords and mental imagery appears to work with short-term memory and transfer, the research suggests that it doesn't produce durable learning – in fact, it leads to “accelerated forgetting.” This is probably because there are so many steps students have to take and multiple opportunities for errors in retrieval.
- *Effects in representative educational contexts* – The research is mixed in studies in different types of classrooms, but overall it's not positive.
- *Implementation issues* – Developing keywords involves skill and time (which is why the keywords are often supplied by the teacher), and research suggests that students' time is better spent on more-productive study techniques.

5. Using imagery for learning text – Attempting to form mental images of text materials while reading or listening:

- *Overall assessment* – **Low utility**
- *Impact in different learning conditions* – Studies have found that using imagery works better when students are listening to a teacher reading a passage aloud than when they are reading it silently.
- *Impact with different students* – Research has been done on different age students, and the results have been mixed, with benefits depending on the type of material and whether students are good at forming mental images.
- *Impact with different learning materials* – This technique works best with learning material that is “image-friendly” and not so well with more-abstract subject matter.
- *Impact with different ways of measuring student learning* – Using imagery is helpful with free-recall or short-answer tests but ineffective with tests with comprehension, inference, and application questions; there isn't research on long-term retention.
- *Effects in representative educational contexts* – Research is thin in this area, but the authors say that using imagery is a “relatively inert strategy.”
- *Implementation issues* – Students need to learn how to form images as they read, and researchers haven't established how much time this would take.

6. Elaborative interrogation – While studying, asking oneself *why* a fact or concept is true and coming up with an explanation:

- *Overall assessment* – **Moderate utility**
- *Impact in different learning conditions* – This technique works best with lists of facts, but there are questions about how well it works with longer or more complex material.

- *Impact with different students* – Studies have shown it works from university students down to the upper-elementary level but not as well in the primary grades; it's also less effective with students who have low levels of prior knowledge in the domain.
- *Impact with different learning materials* – The technique seems to work with many different types of factual material.
- *Impact with different ways of measuring student learning* – Short-term memory of facts is improved, but research needs to be done on whether this technique works with long-term retention.
- *Effects in representative educational contexts* – Research is lacking in this area.
- *Implementation issues* – Students need only minimal training to use this technique – for example, prompting themselves to ask “Why is this true?” every 150 words in a textbook passage.

7. Self-exploration – Explaining how new information is related to known information, or explaining steps taken during problem-solving – for example, a student asking him- or herself, “What parts of this page are new to me? What does this statement mean? Is there anything I still don't understand?”

- *Overall assessment* – **Moderate utility**
- *Impact in different learning conditions* – This technique does well across a range of school conditions.
- *Impact with different students* – Research has found this technique to be effective among younger and older students, but more study is needed on its utility with different achievement levels.
- *Impact with different learning materials* – This technique has been effective with a wide range of materials.
- *Impact with different ways of measuring student learning* – Studies have shown it to be effective across an impressive range of learning outcomes including memory, comprehension, and transfer.
- *Effects in representative educational contexts* – More research is needed here.
- *Implementation issues* – Although students don't need a lot of training to use this technique, it is relatively time-consuming for students to implement well.

8. Interleaved practice – Implementing a schedule of practice that mixes different kinds of problems or materials within a single study session. The opposite of this, which students use most often, is studying each topic in a block and then moving on to the next one – for example, looking at a series of paintings by one artist, then a series of paintings by another artist. The authors say the interleaved technique has great promise but research on it is less robust than it is for most of the other techniques.

- *Overall assessment* – **Moderate utility**

- *Impact in different learning conditions* – Interleaved practice is often used in conjunction with distributed practice, but its efficacy is not dependent on the spacing between study sessions. It’s most effective when students have attained a level of mastery with each skill so they can move from one to another with some facility.
- *Impact with different students* – Most of the research has been done on college students, but a few studies have looked at interleaving with upper-elementary students.
- *Impact with different learning materials* – Researchers have studied interleaving with students learning about artists’ painting styles, mathematics, and other subjects and found different impact in different areas. It is highly effective in mathematics and less effective with learning foreign-language vocabulary.
- *Impact with different ways of measuring student learning* – An intriguing fact is that when studying, students using blocked practice do better than students doing interleaved practice, but on tests, students who used interleaved practice do significantly better. This may be because interleaved practice helps students compare different types of problems and get better at shifting from one to the other. Interleaved practice may also make greater demands on long-term memory and strengthen those neural links.
- *Effects in representative educational contexts* – A few studies have found that motivated students can learn to use interleaving quite quickly.
- *Implementation issues* – Interleaving may take slightly more study time than blocked practice, but the time is well spent, say the authors. They recommend that when teachers present a new skill or topic, they should have students practice that one first, then do a mixed practice with skills from previous units – ongoing, cumulative, interleaved practice throughout the year.

9. Practice testing – Self-testing or taking practice tests on to-be-learned material. “Testing is likely viewed by many students as an undesirable necessity of education,” say the authors, “and we suspect that most students would prefer to take as few tests as possible... This view of testing is... unfortunate, because it overshadows the fact that testing also *improves* learning.” What does this look like? Students working on their own to test themselves on the target material, either with actual or virtual flashcards, completing practice problems, or doing practice tests – all in a low-stakes environment.

- *Overall assessment* – **High utility**
- *Impact in different learning conditions* – Researchers have most often used cued recall (students write down as much as they can remember about a passage without looking back), but other formats have been studied.
- *Impact with different students* – Students of various ages have been studied, but the research is thinner on different student achievement levels and amounts of prior knowledge.
- *Impact with different learning materials* – Studies have affirmed the efficacy of practice testing with a variety of materials.

- *Impact with different ways of measuring student learning* – Research has shown practice testing produces robust learning gains on a variety of short-term and long-term tests and applying information in new settings.
- *Effects in representative educational contexts* – Practice testing has been studied in a wide variety of classrooms with positive results.
- *Implementation issues* – Practice testing is not particularly time-consuming and requires minimal training. The Cornell note-taking method, for example, is quick to learn (students take notes on half of each page and leave a blank column to jot down key terms and questions shortly after taking the notes for self-testing later). Of course feedback on the practice testing is important – either students checking themselves or the teacher providing correctives where necessary.

10. Distributed practice – Implementing a schedule of practice that spreads out study activities over time, versus being massed in a short period of time. “Although cramming is better than not studying at all in the short term,” say the authors, “given the same amount of time for study, would students be better off spreading out their study of content? The answer to this question is a resounding ‘yes.’”

- *Overall assessment* – **High utility**
- *Impact in different learning conditions* – Studies have shown that the key variable is how much time passes between practice/retrieval sessions. For example, to remember something for one week, sessions should be 12 to 24 hours apart. To remember something for five years, sessions should be 6 to 12 months apart. Another variable is how deeply students are processing the information in each practice/retrieval session.
- *Impact with different students* – Researchers have documented the effect of distributed practice on a wide range of ages and student characteristics, but there isn’t good research on different learner characteristics (for example, prior knowledge and motivation).
- *Impact with different learning materials* – Studies have tested the impact of distributed practice on a wide variety of learning materials. It does well with most assessments but less well with complex tasks like airplane control.
- *Impact with different ways of measuring student learning* – The results of distributed practice are strong with all kinds of assessments and strongest with assessments conducted after some time has passed.
- *Effects in representative educational contexts* – Researchers have seen positive results from distributed practice in many types of classrooms.
- *Implementation issues* – One factor that makes it more difficult to get students using distributed practice is that textbooks tend to bunch topics together and not return to them. Another factor is “procrastination scallop” – the tendency of students to increase study time just before an exam rather than spreading it out over the semester. Distributed practice doesn’t use more time than other study techniques, but students need to be convinced of its efficacy and have a little training

on how to do it. Teachers can also help students distribute practice by giving frequent, short tests.

“It is obvious that many students are not using effective learning techniques but could use more-effective techniques without much effort,” conclude the authors, “so teachers should be encouraged to more consistently (and explicitly) train students to use learning techniques as they are engaged in pursuing various instructional and learning goals.”

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