



Smarter Studying: Two Core, Evidence-Based Approaches

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Did you know that research shows there is little relationship between the amount of time spent studying and exam scores or course grades? It's not the quantity of studying that matters but the quality.

So what makes for high-quality studying? This handout presents two core approaches to studying that are supported by research in cognitive psychology, and it suggests tips that derive from those fundamental approaches. One approach focuses on *how* to study, the other on *when* to study.

It can be hard to change old study habits; old habits can feel familiar and comfortable, and it is easy to fall back on them, even when they are not the most effective. After all, they have worked up to a point; because they have gotten you to where you are, you might regard them as tried and true. But as the nature of your intellectual and creative work requires you to engage in more complex and sophisticated thinking, you will need to experiment, try new methods of studying, and figure out what approaches work best given new academic contexts, expectations, and purposes. College offers an opportunity not only to learn about the world around you but also to learn about new, more effective ways of learning.

How to Study: Test yourself

Research from within both education and psychology clearly indicate that retrieval practice and self-testing help you remember what you study.

Why it works

Retrieving information from memory strengthens or reinforces, the neuropathways through which you recall that information (easing future retrieval) and also slows the rate at which you forget that information. Self-testing corresponds to what you would typically do during an exam (e.g., retrieve information from memory and use retrieved information to solve a problem or address a question). That is, it gives you experiential practice in the mode in which you will be asked to perform on the exam. Retrieval practice also gives you feedback that helps you to identify gaps in your knowledge and to then study accordingly.

To maximize the benefit of self-testing, you must actually try to retrieve the information from memory and provide yourself with feedback on whether you were correct. The benefits gained from this approach hinge upon you relying on yourself to recall the information (as opposed to looking up the answer without any cognitive effort), even if your initial attempts result in wrong answers. Consider a wrong answer to be a helpful indicator of where your understanding is shaky and where you will therefore need further study and practice. Although this process might feel difficult and discouraging at first, it does yield long-term benefits.

Try it yourself

- Use flashcards and attempt to retrieve the correct answer from memory before reviewing the back of the flashcard.
- Attempt practice questions at the end of texts (resist the urge to look up the answers first).
- Do problem sets; later, re-work those problems. Do not simply re-read through the work you previously did.
- Explain course material and concepts to peers in such a way that they can understand.
- Close your notes and write everything you can recall from memory in your own words.
- Loosely related to retrieval practice, generating explanations in your own words for information in your textbooks or during lecture will help you get “invested” in the content more, and actually help you retain the content better, even if your initial guess is incorrect. Channel your inner five-year-old and ask yourself “why” - it will help you better understand new content and integrate it with what you already know.

Resources on the science of retrieval practice

- Kang, S. H. K., McDermott, K. B., & Roediger, H. L. (2007). Test format and corrective feedback modify the effect of testing on long-term retention. *European Journal of Cognitive Psychology, 19*(4-5), 528–558.
- Karpicke, J. D., & Roediger, H. L. (2008). The Critical Importance of Retrieval for Learning. *Science, 319*(5865), 966–968.
- Roediger, H. L., & Karpicke, J. D. (2006). Test-enhanced learning: Taking memory tests improves long-term retention. *Psychological Science, 17*, 249-255.

When to Study: Space out your study sessions over time

Robust findings from cognitive psychology research indicate that spacing out your study sessions over time is typically associated with better long-term retention than the alternative of cramming your studying into one long review.

Why it works

Studying at regular, spaced intervals makes learning more manageable for most students, even though many have the perception that it makes learning more disconnected and difficult. The effectiveness of spacing out your studying is driven by the way in which you *relearn* information. As time passes between study events, you forget an amount of what you previously learned. Each time you relearn that information, you reinforce the neuropathways associated with retrieving that knowledge, which in turn slows the rate at which you forget that information.

Try it yourself

- Review content you have not studied in a while, or re-work problem sets you previously completed.
- Create a schedule for when you want to study specific courses or topics. Use important course deadlines (e.g., exam dates) as the starting point and work backwards from that day, planning out when, how long, and how often you would want to study.
- Organize a study group with your classmates that meets at regular intervals (e.g., once per week). Committing to meet with peers is one way to help you will keep up with course material. In addition to offering you structure, company, and constructive social pressure, study groups allow you the opportunity to get clarification on material you do not understand and to engage in retrieval practice by explaining content to peers in your own words. Beware, however, that study groups can quickly transform into unproductive socializing, so creating an agenda or having a structure to such meetings can be handy (e.g., punctuating the meeting with planned, brief breaks, even setting a timer to indicate the start and stopping times for a break).
- Related to spaced learning, interleaving (that is, mixing) topics together within the same study session (different topics from within the same course or materials from different courses altogether) improves your ability to retrieve information later. Despite its difficulty in practice, this technique helps you recognize similarities and differences between topics that you would have otherwise missed, and learning in this way typically matches the conditions under which you will be tested (i.e., on an exam, questions of a particular type or about a particular topic are not necessarily clustered together but rather presented next to questions of different types and topics). Importantly, interleaved learning should not be misinterpreted as multitasking (i.e., studying multiple topics or doing multiple tasks at the same time), which is associated with reduced learning and retention of either topic.

Resources on the science of spaced learning

- Carpenter, S. K., Cepeda, M. J., Rohrer, D., Kang, S. H., & Pashler, H. (2012). Using spacing to enhance diverse forms of learning: Review of recent research and implications for instruction. *Educational Researcher, 24*, 369-378.
- Cepeda, N. J., Pashler, H., Vul, E., Wixted, J. T., & Rohrer, D. (2006). Distributed practice in verbal recall tasks: A review and quantitative synthesis. *Psychological Bulletin, 132*(3), 354–380.
- Zechmeister, E. B., & Shaughnessy, J. J. (1980). When you know that you know and when you think that you know but you don't. *Bulletin of the Psychonomic Society, 15*(1), 41–44.

Beware of . . .

- **Faulty Assumptions.** Metacognition refers to your ability to think about your own thinking and to notice, direct, and shape your thinking. Your ability to monitor your own learning influences your actions, study decisions, and (ultimately) your exam scores. Although people are typically accurate at monitoring their own learning, there are times when our intuitions or assumptions are incorrect. One common faulty assumption students and instructors make is that effortless understanding (i.e., easy learning) during lecture will result in errorless performance on a test. In reality, there is a growing body of research on effortful practice during learning translating into better long-term outcomes. As with exercise, the adage of “no pain, no gain” applies to learning as well.
- **Foresight Bias.** Have you ever heard the expression that “hindsight is 20/20”? Foresight bias refers to the phenomenon that predicting the future can be relatively difficult. If you find that the material feels fluent or memorable to you while you are studying, you might predict that there is no way you would forget that material during the actual exam. When you are studying, you may discount that all of your notes and materials are right in front of you, giving you a false sense of confidence and understanding. However, your confidence may be quite different in your exams, during which your notes and materials are unavailable to you. This illusion of competence suggests that people neglect the differences between their learning environments and testing environments. A great way to overcome this misperception is to test yourself under test conditions before an exam. This will not only improve your ability to retain the content but will also prove to you whether you know the material as well as you think you do.
- **Cramming.** The opposite of spacing out your study sessions over time is to have one long review session immediately prior to an exam. If you have created a study schedule and kept to it, you should not be forced to cram. There are times, however, when other obligations might prevent you from spacing out your study sessions, and you can end up cramming. And that’s okay – cramming before an exam will typically help improve your score. The gains from cramming are short-lived, however, and that content is quickly forgotten. While cramming might help for an impending exam, if you need to know that content for the future (e.g., its content will be on a future exam in your current course or be part of a future course you take), it will be almost as if you are starting from scratch. Avoid cramming when possible, but if you have to do it, be aware that the material you learned while cramming will be forgotten soon after.
- **Rereading, highlighting, & underlining.** These are some of the most common study habits students engage in. While these behaviors might make learning feel easier, they typically do not lead to better academic performance. Rather, these behaviors should be viewed as stepping-stones toward more challenging and effective ways to review content. After initially reading a passage, test yourself and try to remember the most important content of the reading, then go back and check your answers. Did your answers overlap with what you highlighted?

Additional resources,

- Dunlosky, J. (2013). Strengthening the student toolbox: Study strategies to boost learning. *American Educator*, 37, 12-21.
- Dunlosky, J., Rawson, K. A., Marsh, E. J., Nathan, M. J., & Willingham, D. T. (2013). Improving Students’ Learning With Effective Learning Techniques: Promising Directions From Cognitive and Educational Psychology. *Psychological Science in the Public Interest*, 14(1), 4–58.
- Hartwig, M. K., & Dunlosky, J. (2012). Study strategies of college students: Are self-testing and scheduling related to achievement? *Psychonomic Bulletin & Review*, 19, 126–134.
- Isaacson, R. M., & Fujita, F. (2006). Metacognitive knowledge monitoring and self-regulated learning: Academic success and reflections on learning. *Journal of Scholarship of Teaching and Learning*, 6, 39-55.
- Kornell, N., & Bjork, R. A. (2007). The promise and perils of self-regulated study. *Psychonomic Bulletin & Review*, 14(2), 219–224.
- McCabe, J. A. (2011). Metacognitive awareness of learning strategies in undergraduates. *Memory and Cognition*, 39, 462-476.
- Morehead, K., Rhodes, M. G., & DeLozier, S. (in press). Instructor and student knowledge of study strategies. *Memory*, 1–16.

If you have questions or concerns, or would like help setting up study plans that work for you, please contact the BSC to find a time to meet a BSC academic counselor.