



Improve Student Learning

In recent years, researchers in cognitive and educational psychology and other fields related to the learning sciences have greatly improved understanding of effective teaching and learning practices. In a nutshell, they have found that learning is enhanced when teachers and/or students use practices that include “desirable difficulties” (Bjork & Bjork, 2011). In this Teaching Tip, I briefly explain what scientists mean by desirable difficulties, provide examples of ways to incorporate these practices into your teaching, and offer suggestions to pass on to students. I also recommend resources where you and your students can find out more about ways to improve learning.

What are Desirable Difficulties?

Cognitive psychologists Elizabeth and Robert Bjork (2011) use the term “desirable difficulties” to refer to teaching and study practices that are more mentally challenging for students than other methods but that lead to improved learning. Three of the most consistently recommended desirable difficulties are commonly referred to by learning scientists as *retrieval practice*, *distributed practice*, and *elaboration* (Dunlosky, 2013; Roediger, et al., 2012). Students answering test-type questions about content is one example of a retrieval practice. This practice enhances learning substantially more than the study method students typically use—reading text and notes repeatedly (a basic level encoding practice). Retrieval practices enhance learning, in part, because they strengthen and expand the neural retrieval paths an individual will need in the future to recall and/or recognize in a variety of situations previously learned information. Over reliance on less demanding study practices, such as rereading, leads to what learning scientists call an “illusion of knowing”—feeling you know and understanding information when it really is just familiar (Brown et al., 2014). You likely have talked with students affected by this illusion: they study long hours for an exam and feel prepared but are surprised and disappointed by their performance. Because they do not know more effective ways to study, students’ usual solution is to study longer. However, students are more likely to improve their learning via desirable difficulty practices. Below, I explain and provide examples of three key desirable difficulty practices.

Three Desirable Difficulty Practices That Improve Students’ Retention, Understanding, and Mental Retrieval of Information

1. Retrieval practices (e.g., answering questions, reflecting on a reading or lecture content, recalling prior knowledge related to a new topic)

Retrieval practices are more effective than students’ typical study practices, such as highlighting and rereading textbook content and class notes, because the mental effort of retrieving memories builds and strengthens neural connections across them and the pathways students will need to recall and apply learned content in different situations.

Teacher: Ask students about their prior knowledge—e.g., what they may already know about a key person, theory, idea, event, or concept that will come up in lecture or an assigned reading. Give frequent

no- or low-cost quizzes. Begin lectures by asking students to recall key ideas from a previous class or assigned reading. End class or lecture segments by asking students to reflect on what they learned (e.g., 1-minute paper, muddiest point, write a possible exam question).

Student: When preparing to read a textbook chapter, first glance through it looking for key people or concepts that you may already know something about. Recall what you know. As you read, consider how your prior knowledge and experiences relate to what you learn. To improve and gauge your learning, create flash cards of major ideas, concepts, people, etc., and use these to test your knowledge (i.e., do not just read the cards, but use them to ask yourself what you know, then check your answers). Also, test yourself using practice questions in your textbook, on the publisher's website, and from your instructor. After each class, at the end of the day, or while walking or driving home spend a few minutes reflecting on what you read that day and/or learned in class (e.g., what was most important, what might the instructor ask on an exam, what did I not understand?). Using retrieval practices may sound time consuming. However, researchers have found that when students answer practice questions, they perform comparatively better on exams in the long run than students who dedicated the same amount of time simply rereading information.

2. Distributed practice (e.g., spacing out coverage of content, breaking study into spaced out, short sessions)

Distributed practice, also known as spacing out study (SOS), is more effective than massed exposure to content or cramming because the change in activity or situation and passage of time between exposures requires the learner to expend greater mental effort to reconnect with the content upon return. In addition to fostering retrieval pathways, this type of learning experience increases the variety of memory cues associated with content and opportunities for building conceptual and neural connections among memories.

Teacher: Break lecture into short segments and intersperse discussions, small group activities, review questions in between segments. Include a few comprehensive questions on each test and let students know this will be your practice and why (e.g., improves learning).

Student: Space out your reading and study of assigned content across several short sessions of about 20 minutes rather than reading and cramming for hours at a time. Read and study a little for each course daily, switching from course to course (be sure to take a break between sessions).

3. Elaboration (e.g., create own definitions, examples; make meaningful connections across people, ideas; relate course content to experiences)

Elaboration refers to cognitively advanced methods of encoding information that require the learner to think beyond given information (e.g., textbook or instructor provided examples and definitions).

Elaborative practices require much more mental effort from students than their usual chosen way of studying—rehearsing over and over provided definitions and examples—and that greater mental effort pays off by helping the learner better understand, retain, and access what they learn.

Teacher: Demonstrate and encourage students to use frameworks for organizing information, such as tables, that will help them find ways to make comparisons. Use *Think-Pair-Share* activities in class to have students create their own definitions, examples, questions, then pair up to compare and perfect their ideas, and finally share them during a class discussion. If you provide a key word list to students as part of their study guide, list the words alphabetically rather than in the order of content in the textbook and encourage students to look for ways the various key words relate to one another in addition to writing their own definitions and examples.

Student: After reading a definition or examples of key ideas in the textbook, set the book aside, and write your own definition or examples. Also, try to relate ideas to your experiences or think of ways they might inform your future life. To foster originality and your understanding, word your definitions and

examples so they would be understandable to someone not taking your class (e.g., your parent, roommate, friend).

References & Recommended Readings

(*Student and lay audience friendly)

Benassi, V. A., Overson, C. E., & Hakala, C. M. (2014). *Applying science of learning in education: Infusing psychological science into the curriculum*.

This free ebook, by the Society for the Teaching of Psychology, provides extensive information about research supported instructional practices for higher ed instructors.

<http://teachpsych.org/ebooks/asle2014/index.php>

*Bjork, R., & Bjork, E. (2011). *Making things hard on yourself, but in a good way: Creating desirable difficulties to enhance learning*. In M. A. Gernsbacher et al (Eds) *Psychology and the real world: Essays illustrating fundamental contributions to society*. NY: Worth.

The authors explain “desirable difficulties” and provide information that could help teachers and students apply the practices. https://bjorklab.psych.ucla.edu/wp-content/uploads/sites/13/2016/04/EBjork_RBjork_2011.pdf

*Brown, P.C., Roediger, III, H.L., & McDaniel, M.A. (2014). *Make it stick: The science of successful learning*. Cambridge, MA: Harvard Univ.

I recommend this engaging popular press book to anyone interested in improving teaching or learning. The authors use stories of people in a variety of professions (a paratrooper, neurosurgeon, med student, biology professor) to demonstrate effective teaching and learning practices. I have assigned this book to students and organized faculty readings of it. The reaction from both groups has been enthusiastic.

*Chew, S. (2010). Improving classroom performance by challenging student misconceptions about learning. *Observer*, 23(4).

Chew is a well-known authority on effective teaching and learning practices. I also recommend his videos available on YouTube in which he explains and demonstrates effective study practices.

*Dunlosky, J. (2013, Fall). Strengthening the student toolbox: Study strategies to boost learning. *American Educator*.

If you only have time to read one article related to this Teaching Tip, Dunlosky’s is the one I most recommend. He explains several effective teaching and learning practices and provides suggestions for implementation. This article also can help students learn how to study more effectively and why their usual study practices may fail them on exams. My students’ typical reaction after reading this article has been “why didn’t someone tell us this sooner.”

<https://files.eric.ed.gov/fulltext/EJ1021069.pdf>

Kornel, N., Hays, M. J., & Bjork, R. A. (2009). Unsuccessful retrieval attempts enhance subsequent learning. *J of Exp Psych*, 35, 989-98.

From this article, we learn that even when learners answer test questions incorrectly, their subsequent learning is improved. This suggests a practice such as having students attempt to answer a few big idea questions to the best of their ability before a learning experience. Of course, the reason for this practice should be explained to students and done ungraded or graded for participation.

Putnam, A. L., Sungkhasette, V. W., & Roediger, III, H. L., (2016). Optimizing learning in college: Tips from cognitive psychology. *Perspectives on Psychological Science*, 11, 652-60.

This article may be helpful to students, especially those newer to college, and any instructor who wants to improve student learning. Tips for instructors include emailing students before the semester to advise them to acquire the textbook and begin browsing it. Tips for students include an explanation of the learning advantages of handwriting class notes over typing them.

Roediger, III, H. L., Putman, Smith (2011). Ten benefits of testing and their application to educational practice. *Psychology of Learning and Motivation*, 55, 1-36.

The information in this article answers questions teachers may have about how to best use practice testing in the classroom and can help teachers explain the benefits of practice testing and frequent classroom tests to students.

Roediger, III, H. L. & Pyc, M. A. (2012). Inexpensive techniques to improve education: Applying cognitive psychology to enhance educational practice. *Journal of Applied Research in Memory and Cognition*, 1, 242-48.

The authors review the three effective teaching/learning practices highlighted in this Teaching Tip, explain research supporting the practices, and suggest ideas for application.

*Willingham (2008-9, Winter). Ask the cognitive scientist: What will improve a student's memory? *American Educator*. <https://www.aft.org/ae/summer2019/willingham>

Willingham writes a regular column for the American Educator magazine in which he explains findings from the learning sciences. If you want to learn more about effective teaching and learning practices, I also recommend Willingham's website and other writings.