

LEARNING—THE FLIP SIDE OF TEACHING

Two Books That Review the Scientific Evidence for How People Learn:

Ambrose SA, Bridges MW, DiPietro M, Lovett MC, Norman MK (2010) *How Learning Works: Seven Research-Based Principles for Smart Teaching*. Jossey-Bass. ISBN 978-0470484104

Brown PC, Roedigger HL III, McDEaniel MA (2014) *Make it Stick. Science of Successful Learning*. Belnap Press Of Harvard Univ. Press, Cambridge. ISBN 978-0-674-72901-8

LEARNING STRATEGIES FROM *MAKE IT STICK*:

What *Not* to Do

Do not re-read your notes or text over and over until you are familiar with it. This provides only a false sense of mastery without real learning.

Three Keystone Strategies For Learning

1. *Practice Retrieving New Learning From Memory*

- Should be the primary study practice in place of re-reading
- After reviewing notes/text once or twice do the following:
- Self-quizzing
- While going over notes and text, pause periodically to ask yourself questions
 - what are the key ideas?
 - what terms/ideas are new to me?
 - how would I define them
- Generate questions and write the answers down
- Flashcards—write questions on them with answers on back; keep shuffling
- Set aside time every week for self-quizzing on recent and older material
- Always check your answers to make sure you're not off-track
- Use quizzing to identify areas of weakness and focus studying there
- The harder it is to recall new learning, the greater the benefit to doing so

IMPORTANT: *Effective learning usually feels difficult.* Traditional re-reading of notes and text until they are familiar feels comfortable because one develops fluency with the text. However, this is not indicative of learning, only familiarity with that particular text. Retrieval practice, in contrast, often feels hard to do. It should. This indicates actual learning. *Learning, like working out, should be painful! If it's not, then no real progress is being made.*

2. *Space Out Retrieval Practice*

- Space out self-quizzing sessions so that some time elapses between sessions
- Frequency depends on density of information and the speed with which you forget things
- Even material that is well-mastered must be reviewed periodically at lower frequency
- Repetitive practice in one long period of time creates a false sense of mastery because it employs short-term memory; gains will quickly be lost. A lot of practice is good, but only if it is spaced out

- Spacing of retrieval can be aided by interleaving material from two different subjects so that one is forced continually to refresh one's mind on each topic

3. *Interleave the Study of Different Problem Types*

- During study, mix-up topics, examples, specimens, etc.
- Rather than focusing on one type of problem for a large block of time, gain rudimentary mastery of a variety of topics/problems and then return to them randomly, i.e., 'interleaving' the different topics as you study them

Additional Strategies

1. *Elaboration*—Find additional layers of meaning in new material, e.g., relate material to what you already know; explain the material to someone else in your own words, or explain how the material relates to some other aspect of life. In some cases, developing a visual image of a phenomenon helps, a kind of metaphor, e.g., for heat transfer think of your hands wrapped around a warm cup of coffee or cocoa. Drawing pictures might help.

2. *Generation*—Attempt to answer a question or solve a problem before being shown the answer. 'Experiential learning' is a form of generation—a student that works through a problem hands on attempting to solve it for themselves without first being given the answer is more likely to retain the solution.

3. *Reflection*—The act of taking a few minutes to review what has been learned in a recent class or experience and asking oneself questions. A combination of retrieval practice and elaboration.

4. *Calibration*—The act of aligning your judgments of what you know and don't know with objective feedback so as to avoid being carried off by the illusions of mastery. We are all subject to cognitive illusions/delusions, e.g., mistaking fluency with a text for mastery of the underlying content. Use self-quizzes and practice tests (maybe questions written by a classmate) and answer all questions (don't skip over some because you 'think' you know the answer) to obtain objective feedback about actual mastery. If you don't do it yourself, the calibration will happen at the first exam!

5. *Mnemonic Devices*—These are mental devices that aid retrieval of information from memory. They might be as simple (and ridiculous) as using easily memorized sentences to remember long lists of terms in order, e.g., the twelve cranial nerves, anterior to posterior: "On old Olympus towering top a Finn and German viewed some hops" (olfactory, optic, oculomotor, trochlear, trigeminal, abducens, facial, auditory, glossopharyngeal, vagus, spinal accessory, hypoglossal) (many versions exist, including filthy ones beginning with "Oh, Oh, Oh..."). It can be helpful to ask students to make up their own such mnemonic. More complex memory retrieval devices include creation of something called a 'memory palace', which is worth looking into.