

Objective: Balancing learning for exams with conceptual learning, and addressing learning gaps effectively

3 stages of Learning according to the science of learning

1. Initial **encoding** of information is held in short-term working memory before being consolidated into a cohesive representation of knowledge in long-term memory.
2. **Consolidation** reorganizes and stabilizes memory traces, gives them meaning, and makes connections to past experiences and to other knowledge already stored in long-term memory.
3. **Retrieval** updates learning and enables you to apply it when you need it.

Myths around learning strategies

Myth	Fact
1. Reviewing, rereading, and highlighting are effective study strategies.	Elaboration, generation, and reflection are effective study strategies
2. Repeated exposure, easy activities, and efficient or speedy practices promote learning.	Retrieval practice improves knowledge and retention.
3. Learning is best achieved when we focus on a single topic or activity, when we are “single-minded.”	Interleaving, or spaced, varied practice improves retention and knowledge

As an educator

[Read Case study of an educator: Michael D. Matthews, Psychology Professor, U.S. Military Academy at West Point](#)

Teach Students How to Study

1. **Use frequent quizzing:** This helps students consolidate learning and interrupt the process of forgetting.
 - a. Start a class by quizzing
 - b. Students find **quizzing more acceptable** when it is predictable, simple, quick and the stakes for any individual quiz are low.
 - c. Make quizzing and practice exercises **count toward the course grade**, even if for very low stakes.
 - d. Allow children to **re-examine their own test with an evaluation criteria:** For eg. one teacher used the Bloom's taxonomy as evaluation criteria - one that reflects learning at the level of knowledge, a more thorough answer that reflects understanding, a yet more complex answer that reflects analysis, and so on. When students get their tests back, they also receive the answer key and are asked to identify where their answers fell on the taxonomy and to think about what they need to know in order to respond at a higher level of learning. showing exam results at higher levels on Bloom's taxonomy.
 - e. Encourage a **Testing group vs study group**
 - a) In a testing group, they all wrestle with a question together, without opening the textbook.
 - b) Then one student is sent to the whiteboard to try to explain the concept.
 - c) As the student struggles, perhaps putting up the pieces of the answer she knows, the rest of the group are instructed to test her by asking questions whose answers will lead her to the larger concept.

“Every five minutes or so I throw out a question on the material we just talked about, My class opens with a quiz on the learning objectives from the assigned reading.”

2. Create **study tools that incorporate retrieval practice, generation, and elaboration.**
 - a. **Pre-work:** Solve a new kind of problem before coming to the class where the solution is taught. Ask students to write as many questions they can on a topic before actually going through it - and then share what their responses are
 - b. **Question debates:** Ask and let students write three possible answers on the whiteboard up front and then vote on which answer they think is correct by raising the number of fingers that corresponds with the answer on the board. You can instruct students to find somebody with fingers “different from yours and talk to them and figure out who has the correct answer.”
 - c. Enable **student demonstrations**, or group work aimed at understanding and articulating the larger concepts underlying the matter at hand.

- d. **Practice tests:** Practice tests that students can download and use to review material and to calibrate their judgments of what they know and don't know
 - e. **Written reflection:** Writing exercises that require students to reflect on past lesson material and relate it to other knowledge or other aspects of their lives
 - f. **Synthesis sheets:** Exercises that require students to generate short statements that summarize the key ideas of recent material covered in a text or lecture. Eg. I illustrated the prior week's material in drawings annotated with key ideas, arrows, and graphs.
 - g. **Free recall:** Spend ten minutes at the end of each day sitting with a blank piece of paper on which to write everything they can remember from class. At the end of ten minutes, they're to go to their class notes and find out what they remembered and what they forgot, and to focus on the material they forgot.
3. **Space, interleave, and vary topics** and problems covered in class so that students are frequently shifting gears as they have to "reload" what they already know about each topic in order to figure out how the new material relates or differs.
 4. **Be Transparent:** Help your students understand the ways you have incorporated desirable difficulties into your lessons, and why. Be up front about some of the frustrations and difficulties this kind of learning entails and explain why it's worth persisting.

"Clear learning objectives prior to each class, coupled with daily quizzing and active problem solving with feedback, keep students focused, awake, and working hard."

As a self study as a learner (for formal learning)

[Read Case study for Self Learning - Michael Young, Medical Student](#)

1. **Question & answer prior to taking in information on a topic:** explain beforehand the key ideas you expect to find in the material and how you expect they will relate to your prior knowledge. Start by answering questions given at the end of a topic.
2. **Relate the material to what you already know:** Explain it to somebody else in your own words, or explain how it relates to your life outside of class. Start by creating your own questions on a topic. Discuss the topic with peers.
3. **Discover metaphors or visual images for the new material**
 - a. **Create metaphors and stories:** The funnier and more evocative the images or story the better. Metaphors are never perfect, but then, in science, all models are just metaphors which means they break down at some point. eg.

Angular momentum in physics- visualize how a figure skater's rotation speeds up as her arms are drawn into her body.

- b. **Use Mnemonics for chunking** - By making meaningful groups and abbreviations, you can simplify and chunk what you're trying to learn so you can more easily store it in memory. Eg a) 1491625, b) 1, 4, 9, 16, 25, c) 1sq, 2sq, 3sq; glance over the headers of the a chapter
 - c. **Make Summary sheets**. You engage it by making the effort to explain the material yourself, in your own words—connecting the facts, making it vivid, relating it to what you already know, using tools like PowerPoint slides, mind maps, summary sheets
4. **Reflect:** Take a few minutes to review what has been learned in a recent class or experience and asking yourself questions.
- a. What went well? What could have gone better?
 - b. What other knowledge or experiences does it remind you of?
 - c. What might you need to learn for better mastery, or what strategies might you use the next time to get better results?
 - d. C5Q as a tool (reflections on being and doing)
5. **Rephrase and recall instead of rereading:** When you read a text or study lecture notes, pause periodically to ask yourself questions like these, without looking in the text:
- i. What are the key ideas?
 - ii. What terms or ideas are new to me?
 - iii. How would I define them?
 - iv. How do the ideas relate to what I already know?
6. **Quiz yourself frequently:** When you quiz yourself, check your answers to make sure that your judgments of what you know and don't know are accurate. Making errors will not set you back, so long as you check your answers and correct your mistakes.
7. **Create a spaced practice schedule:**
- a. Establish a **schedule of self-quizzing** that allows time to elapse between study sessions.
 - b. **How much time?** It depends on the material. If you are learning a set of names and faces, you will need to review them within a few minutes of your first encounter, because these associations are forgotten quickly.
 - c. If you use **flashcards**, don't stop quizzing yourself on the cards that you answer correctly a couple of times. Continue to shuffle them into the deck until they're well mastered.
 - d. **Study of two or more topics**, so that alternating between them requires that you continually refresh your mind on each topic as you return to it. Gains made during single-minded repetitive practice come from short-term memory and quickly fade.
 - e. When you structure your study regimen, once you reach the point where you understand a new problem type and its solution but your grasp of it is still rudimentary, scatter this problem type throughout your practice sequence so that you are alternately quizzing yourself on various problem types and retrieving the appropriate solutions for each.

New strategies for learning - Break the illusions of learning

1. **Interleaving** is spacing out study and practice in installments and allowing time to elapse between them makes both the learning and the memory stronger, in effect building habit strength. At a minimum, enough time so that a little forgetting has set in. The German scientist Sebastian Leitner developed his own system for spaced practice of flashcards, known as the Leitner box.
2. **Generation**: You can practice generation when reading new class material by trying to explain beforehand the key ideas you expect to find in the material and how you expect they will relate to your prior knowledge.
3. **Chunking through Mnemonics**- Greek word for memory, and mnemonic devices are like mental file cabinets. They give you handy ways to store information and find it again when you need it.
4. **Reflection**: is a combination of retrieval practice and elaboration that adds layers to learning and strengthens skills. Reflection is the act of taking a few minutes to review what has been learned in a recent class or experience and asking yourself questions.
5. **Retrieval** : Repeated effortful recall or practice helps integrate learning into mental models. The greater the effort to retrieve learning, provided that you succeed, the more that learning is strengthened by retrieval. This effortful retrieval both strengthens the memory but also makes the learning pliable again, leading to its reconsolidation. Reconsolidation helps update your memories with new information and connect them to more recent learning.
6. **Avoid Einstellung** is when your initial thought, an idea you've already had in mind, or a neural pattern you've already developed well and strengthened, prevents a better idea or solution from being found. Or keeps you from being flexible enough to accept new, better, or more appropriate solutions. The Law of Serendipity is helpful. Lady Luck favors the one who tries. Just pick one tiny thing out to learn, then another.
7. **Focused and diffuse modes of learning**
The focus mood is centered on the prefrontal cortex and it often seems to involve thinking about things you are somewhat familiar with. For example if you're familiar with multiplication and you're trying to solve a multiplication problem, or you're trying to find a word that rhymes with another word. But if you're trying to solve or figure out something new, it often cries out for the more broad ranging perspectives of the diffuse mode. This mode, as it turns out, is representative of the brain's many neural resting states. Creative

thinkers throughout history, whatever their discipline have found ways to access the diffuse mode often more directly and quickly.

Reference:

1. Make it Stick- Science of successful learning - Peter C brown and Henry L Roediger
2. [Learning to learn - Barabara Oakley](#)