



CAMPBELL
UNIVERSITY

Jerry M. Wallace
School of Osteopathic Medicine

A PRE-MATRICULATION READING ON:

The Science and Strategies for Successful Learning and Study

July 17, 2023

Prepared by Yen-Ping Kuo, PhD

CUSOM Academic Center for Excellence

Contains highlights and excerpts from:

- **Brown**, P. C., McDaniel, M. A., & Roediger, H. L. (2014). *Make It Stick*. Cambridge, Massachusetts: Harvard University Press. **Available through CUSOM e-library**
https://campbell.primo.exlibrisgroup.com/permalink/01CAMPBELL_INST/1ogemm4/alma991004084369705096
- **Weidman**, J. and Baker, K. (2015) *The Cognitive Science of Learning: Concepts and Strategies for the Educator and Learner*. *Neuroscience In Anesthesiology and Perioperative Medicine*. 121(6):1586-1599.
https://campbell.primo.exlibrisgroup.com/permalink/01CAMPBELL_INST/h4a75h/ovid00132586-201610000-00011
- Six Strategies for Effective Learning. <http://www.learningscientists.org/> Accessed July 16, 2022

Embarking on the journey of learning medical science with a scientific approach!!



Let's start with a case study: A Real Story of Michael Young

(Brown) “Young entered medical school without the usual foundation of premed coursework. His classmates all had backgrounds in biochemistry, pharmacology, and the like.... The scope of the challenge that lay before him became abruptly evident. Despite his spending every available minute studying his coursework, he barely eked out a 65 on his first exam. “Quite honestly, I got my butt kicked,” he says. “I was blown away by that. I couldn’t believe how hard it was. It was nothing like any kind of schooling I had done before. I mean, you come to class, and in a typical day you get about four hundred PowerPoint slides, and this is dense information.”

As his first exam made all too clear, the road ahead went straight up. If he had any hope of climbing it, something about his study habits had to change....

Since spending more time studying wasn’t an option, Young had to find a way to make studying more effective. He started reading empirical studies on learning and became deeply interested in the testing effect.....

By the time he started his second year, Young had pulled his grades up from the bottom of his class of two hundred students to join the high performers, and he has remained there ever since....

So what did change? He explains it this way: I was big into reading, but that’s all I knew how to do for studying. I would just read the material and I wouldn’t know what else to do with it. So if I read it and it didn’t stick in my memory, then I didn’t know what to do about that. What I learned from reading the research [on learning] is that you have to do something beyond just passively taking in the information. Of course, **the big thing is to figure out a way to retrieve the information from memory, because that’s what you’re going to be asked to do on the test. If you can’t do it while you’re studying, then you’re not going to be able to do it on the test.**”

But, how can you catch every drop of water coming from the water hydrant? Or, do you have to take it ALL?

Fruitful Learning Based on Deep-rooted Understanding of Learning

You have been academically successful to this point and are now ready to step up to an extreme challenge. Just like many elite athletes and musicians embarking on a new level of competition must reassess their performance and improve their mental capacity and practical skills to meet challenges, you too must critically assess your mindset and skills in learning. According to Brown et al. and Weidman et al., the following understanding and fundamental principles of learning hold tremendous importance for a deep-rooted success.

“(Weidman) Goal Orientation: Learning Versus Performance Orientation

There are 2 predominant goal orientations: “performance orientation” and “learning orientation.” Individuals with a performance orientation have a primary goal of validating their abilities, mainly by demonstrating their abilities to others. Because their primary goal is to validate their abilities, they also try to avoid revealing that they do not understand something or are not able to perform a task correctly. In contrast, individuals with a learning orientation have the primary goal of increasing their competency or mastery of a topic. **Their actual mastery matters much more to them than how their mastery is perceived by others.**

“(Brown) Learning is misunderstood

Many people believe that their intellectual ability is hard-wired from birth, and that failure to meet a learning challenge is an indictment of their native ability. But every time you learn something new, you change the brain—the residue of your experiences is stored. It’s true that we start life with the gift of our genes, but it’s also true that we become capable through the learning and development of mental models that enable us to reason, solve, and create. In other words, the elements that shape your intellectual abilities lie to a surprising extent within your own control.....

The popular notion that you learn better when you receive instruction in a form consistent with your preferred learning style, for example as an auditory or visual learner, is not supported by the empirical research. **People do have multiple forms of intelligence to bring to bear on learning, and you learn better when you “go wide,” drawing on all of your aptitudes and resourcefulness, than when you limit instruction or experience to the style you find most amenable.....**

Learning is deeper and more durable when it’s effortful. Learning that’s easy is like writing in sand, here today and gone tomorrow. **We are poor judges of when we are learning well and when we’re not.** When the going is harder and slower and it doesn’t feel productive, we are drawn to strategies that feel more fruitful, unaware that the gains from these strategies are often temporary....

Rereading text and massed practice of a skill or new knowledge are by far the preferred study strategies of learners of all stripes, but they’re also among the least productive.....Cramming for exams is an example. **Rereading and massed practice give rise to feelings of fluency that are taken**

to be signs of mastery, but for true mastery or durability these strategies are largely a waste of time.....

If rereading is largely ineffective, why do students favor it? familiarity with a text and fluency in reading (it) can create an illusion of mastery. As any professor will attest, students work hard to capture the precise wording of phrases they hear in class lectures, laboring under the misapprehension that the essence of the subject lies in the syntax in which it's described. Mastering the lecture or the text is not the same as mastering the ideas behind them. However, repeated reading provides the illusion of mastery of the underlying ideas. **Don't let yourself be fooled. The fact that you can repeat the phrases in a text or your lecture notes is no indication that you understand the significance of the precepts they describe, their application, or how they relate to what you already know about the subject."**

The above described "illusion of mastery" is an example of poor metacognition, defined as the act of thinking about one's own thinking: or what we know about what we know. Being accurate in monitoring what we know and don't know, and thus effectively modify our acts of learning, is critical to achieve a desired learning outcome.

"(Weidman) Metacognition

Metacognition scenario: You are assigned to provide anesthesia for a patient requiring tracheal resection and reconstruction. The night before the surgery, you read a chapter on the intricacies of the surgical procedure as well as a journal article on appropriate anesthetic management. After your review, you go to bed feeling well prepared for the case. However, the next day you are not able to easily remember some of the key concepts you thought you had mastered the night before.....

A related topic is metacomprehension, which is the term used to describe the awareness or understanding an individual has regarding his or her own level of comprehension about a topic. Accurate metacomprehension correlates with improved study patterns and better performance during testing. More efficient learning occurs from learners with high metacomprehension, because they allocate the appropriate amount of time to subjects that are less well understood and spend little time reviewing items that have already been mastered. Learners should develop study habits that focus on improving metacognition. Deliberately creating a plan of how to approach a study topic can result in increased metacognition. Once planning is completed and study has commenced, it is then important to periodically evaluate understanding to ensure that mastery of the previously reviewed concepts has been retained...."

Strategies that Promote Metacognition and Enhance Study Outcomes

Back to Michael Young:

(Brown) “He became more mindful of that when he studied. “I would stop. ‘Okay, what did I just read? What is this about?’ I’d have to think about it. ‘Well, I believe it happens this way: The enzyme does this, and then it does that.’ And then I’d have to go back and check if I was way off base or on the right track.” The process was not a natural fit. “It makes you uncomfortable at first. If you stop and rehearse what you’re reading and quiz yourself on it, it just takes a lot longer. If you have a test coming up in a week and so much to cover, slowing down makes you pretty nervous.” But the only way he knew of to cover more material, his established habit of dedicating long hours to rereading, wasn’t getting the results he needed. As hard as it was, he made himself stick to retrieval practice long enough at least to see if it worked. “You just have to trust the process, and that was really the biggest hurdle for me, was to get myself to trust it. And it ended up working out really well for me.” His comments are illuminating.”

- **On deciding what’s important:** “If it’s lecture material and you have four hundred PowerPoint slides, you don’t have time to rehearse every little detail. So you have to say, ‘Well this is important, and this isn’t.’ Medical school is all about figuring out how to spend your time.” On making yourself answer the question: “When you go back and review, instead of just rereading you need to see if you can recall the learning. Do I remember what this stuff was about? You always test yourself first. And if you don’t remember, then that’s when you go back and look at it and try again.”
- **On finding the right spacing:** “I was aware of the spacing effect, and I knew that the longer you wait to practice retrieval the better it is for memory, but there’s also a trade-off with how successful you are when you try to recall it. When you have these long enzyme names, for example, and this step-by-step process of what the enzyme is doing, maybe if you learn ten steps of what the enzyme is doing, you need to stop and think, can I remember what those ten steps are? Once I found a good strategy for how much to space practice and I started seeing consistent results, it was easy to follow from there because then I could just trust the process and be confident that it was going to work.”
- **On slowing down to find the meaning:** Young has also slowed down the speed at which he reads material, thinking about meaning and using elaboration to better understand it and lodge it in memory. “When I read that dopamine is released from the ventral tegmental area, it didn’t mean a lot to me.” The idea is not to let words just “slide through your brain.” To get meaning from the dopamine statement, he dug deeper, identified the structure within the brain and examined images of it, capturing the idea in his mind’s eye. “Just having that kind of visualization of what it looks like and where it is [in the anatomy] really helps me to remember it.” He says there’s not enough time to learn everything about everything, but pausing to make it meaningful helps it stick.”

Young’s story exemplified some of the following important learning strategies supported by cognitive psychologists.

Now, let's visit the strategies revealed from Young's story

(1) Spaced Learning/Retrieval Practice

(Weidman) “*Spaced learning* is the practice of learning information by studying the material with distinct time intervals between each study period. In contrast, *massed learning* is learning information without significant interruption. Cramming for an examination is an example of *massed learning*spaced learning is always superior to massed learning. For example, a total study time of 2 hours is more effective when used as 4 30-minute sessions (with space between each session) compared with a single 2-hour session regardless of the time between sessions....

- **(Brown)** Effortful retrieval makes for stronger learning and retention. We're easily seduced into believing that learning is better when it's easier, but the research shows the opposite: when the mind has to work, learning sticks better. The greater the effort to retrieve learning, provided that you succeed, the more that learning is strengthened by retrieval.To be most effective, retrieval must be repeated again and again, in spaced out sessions so that the recall, rather than becoming a mindless recitation, requires some cognitive effort. Repeated recall appears to help memory consolidate into a cohesive representation in the brain and to strengthen and multiply the neural routes by which the knowledge can later be retrieved.
- **(Weidman)** Longer interstudy intervals are generally associated with better long-term retention (provided the interstudy interval is not increased to the point that the learner completely forgets the previous learning episode).....
- **(Weidman)** spaced learning works equally well with verbal tasks and motor tasks.....For an equivalent total study duration, spaced learning will result in better long-term retention of the material. Both spaced learning and retrieval are examples of knowledge acquisition and retention strategies.”
- **(Brown)** on “How to use spaced practice as a study strategy: Establish a schedule of self-quizzing that allows time to elapse between study sessions. 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. New material in a text may need to be revisited within a day or so of your first encounter with it. Then, perhaps not again for several days or a week. When you are feeling more sure of your mastery of certain material, quiz yourself on it once a month. Over the course of a semester, as you quiz yourself on new material, also reach back to retrieve prior material and ask yourself how that knowledge relates to what you have subsequently learned. 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. Only then set them aside— but in a pile that you revisit periodically, perhaps monthly. Anything you want to remember must be periodically recalled from memory.”

(Brown) “Another way of spacing retrieval practice is to interleave the 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.....interleaving is unpopular..... But the research shows unequivocally that mastery and long-term retention are much better if you interleave practice than if you mass it.”

(2) Practice Retrieving New Learning from Memory

(Brown) ”The power of retrieval as a learning tool is known among psychologists as the testing effect. ... In his essay on memory, Aristotle wrote: “exercise in repeatedly recalling a thing strengthens the memory.” Francis Bacon wrote about this phenomenon, as did the psychologist William James. Today, we know from empirical research that practicing retrieval makes learning stick far better than re-exposure to the original material does. This is the testing effect, also known as the retrieval-practice effect.

- **(Brown)** “Retrieving knowledge and skill from memory should become your primary study strategy in place of rereading. (Note by Kuo: The analogy of rereading here for CUSOM students includes re-listening to the lecture or passively re-reading the slides or book chapters).”
- **(Weidman)** “Repeated retrieval is one of the most effective strategies to ensure that new material is learned in a durable fashion. Retrieval-based learning outperformed the well-known concept mapping technique. Retrieval exercises such as self-testing are also an effective way of improving metacognition. Self-testing reveals gaps in knowledge and allows for more efficient and focused learning. Research indicates the usefulness of repeated recall.”
- **(Brown)** “When you read a text or study lecture notes, pause periodically to ask yourself questions like these, without looking in the text: What are the key ideas? What terms or ideas are new to me? How would I define them? How do the ideas relate to what I already know? Many textbooks have study questions at the ends of the chapters, and these are good fodder for self- quizzing....
Generating questions for yourself and writing down the answers is also a good way to study. When you quiz yourself, check your answers to make sure that your judgments of what you know and don’t know are accurate. Use quizzing to identify areas of weak mastery, and focus your studying to make them strong.....
The harder it is for you to recall new learning from memory, the greater the benefit of doing so. Making errors will not set you back, so long as you check your answers and correct your mistakes.” [Note by Kuo: Note the quizzing step is for you to get feedback on your learning; you do not (and should not) need to wait until you feel you have mastered the materials before doing so].”
- **(Weidman)** On building long-term memory by repeated retrieval: “after the target study material can be successfully recalled once, resulting in significant positive effects on long-term retention, additional study by encoding seems to provide little long-term benefit. Textbooks, journal articles, and didactic lectures are well suited for the initial exposure to new material.

However, if the material is deemed important to know for long-term purposes, then further study of that material should incorporate active recall instead of simple review. Flashcards, when used appropriately, function well to promote retrieval.

(3) Structured Deliberate Practice to Improve Performance

- **(Weidman)** “Deliberate practice focuses on overcoming weaknesses. The performance is monitored, and feedback is provided with the goal of enhancing performance.There are abundant opportunities for learners in the medical field to incorporate deliberate practice into their education.....Evaluation can be accomplished by self-testing through practice questions or flash cards, or even simply through deliberate mental review. The key is that by focusing on the process of learning and by regular self-evaluation, students can increase their awareness of what is known and what needs additional review (i.e., their metacognition) and thus improve learning.”
- **(Brown)** This skill is better acquired through interleaved and varied practice than massed practice. In virtually all areas of learning, you build better mastery when you use testing as a tool to identify and bring up your areas of weakness....If you’re just engaging in mechanical repetition, it’s true, you quickly hit the limit of what you can keep in mind. However, if you practice elaboration, there’s no known limit to how much you can learn. Elaboration is the process of giving new material meaning by expressing it in your own words and connecting it with what you already know.”
- **(Brown)** There’s an essential kind of learning that comes from reflection on personal experience. Reflection can involve several cognitive activities that lead to stronger learning: retrieving knowledge and earlier training from memory, connecting these to new experiences, and visualizing and mentally rehearsing what you might do differently next time.
- **(Brown)** The stronger one’s knowledge about the subject at hand, the more nuanced one’s creativity can be in addressing a new problem. Just as knowledge amounts to little without the exercise of ingenuity and imagination, creativity absent a sturdy foundation of knowledge builds a shaky house.

Additional Small Study Tips That Can Amount to Increased Metacognition

- *Summarizing study material after a study session*
- *Generating written/table/algorithm summaries of the material reviewed*
- *Summarizing after a short time-delay to promote long-term memory*
- *Taking practice tests*
- *Building more repetition; the more times you go over the material the better chance you have of storing it permanently*

Increase Your Ability Beyond Ordinary “Wisdom”

Get Beyond Learning Styles

- **(Brown)** “The idea that individuals have distinct learning styles has been around long enough to become part of the folklore of educational practice and an integral part of how many people perceive themselves. We acknowledge that everyone has learning preferences, but we are not persuaded that you learn better when the manner of instruction fits those preferences. Yet there are other kinds of differences in how people learn that do matter. **One difference that appears to matter a lot is how you see yourself and your abilities.**.....The stories we create to understand ourselves become the narratives of our lives, explaining the accidents and choices that have brought us where we are: what I’m good at, what I care about most, and where I’m headed. What you tell yourself about your ability plays a part in shaping the ways you learn and perform – how hard you apply yourself, for example, or your tolerance for risk-taking and your willingness to persevere in the face of difficulty. **But differences in skills, and your ability to convert new knowledge into building blocks for further learning, also shape your routes to success.**
- **(Brown)** “Each of us has a large basket of resources in the form of aptitudes, prior knowledge, intelligence, interests, and sense of personal empowerment that shape how we learn and how we overcome our shortcomings. Some of these differences matter a lot— for example, our ability to abstract underlying principles from new experiences and to convert new knowledge into mental structures. Other differences we may think count for a lot, for example having a verbal or visual learning style, actually don’t.”

Improve Your Ability by Optimizing Your Brain’s Processes for Encoding and Consolidating New Information

- **(Brown)** “Durable, robust learning requires that we do two things. First, as we recode and consolidate new material from short- term memory into long- term memory, we must anchor it there securely. Second, we must associate the material with a diverse set of cues that will make us adept at recalling the knowledge later. Having effective retrieval cues is an aspect of learning that often goes overlooked. The task is more than committing knowledge to memory. Being able to retrieve it when we need it is just as important...”
- It appears that embedding new learning in long-term memory requires a process of consolidation, in which memory traces (the brain’s representations of the new learning) are strengthened, given meaning, and connected to prior knowledge— a process that unfolds over hours and may take several days. Rapid-fire practice leans on short-term memory. Durable learning, however, requires time for mental rehearsal and the other processes of consolidation. Hence, spaced practice works better. The increased effort required to retrieve the learning after a little forgetting has the effect of retriggering consolidation, further strengthening memory.Repeated retrieval not only makes

memories more durable but produces knowledge that can be retrieved more readily, in more varied settings, and applied to a wider variety of problems....”

- Another cognitive difference that appears to matter is whether you are a “rule learner” or “example learner,” and the distinction is somewhat akin to” many principles we just discussed. *(Kuo Note: this is extremely important; you learn rules largely in class but are tested through the use of scenarios and cases that require you to apply that knowledge. Thus, it is important to practice application during the consolidation phase by using/creating examples or questions. Being able to develop questions that test at a higher cognitive/Bloom taxonomy level is particularly beneficial)*

(Weidman et al.)

Table 2. Concepts for the Learner	
Description	Relationship to learning
Goal orientation: Goal orientation refers to the implicit goals that individuals have when in achievement situations. An individual whose main goal is to increase competence and strive toward mastery is said to have a learning orientation. These individuals tend to believe that their skills and abilities can be increased through effort and strategy. An individual whose main goal is to validate their inherent ability by demonstrating to others that they are competent is said to have a performance orientation. These individuals tend to believe that their skills and abilities are fixed.	Learning-orientated individuals readily accept feedback on how to improve and are willing to ask questions when they do not understand something. Performance-oriented individuals are unlikely to try difficult problem because they may fail. Both goal orientations are equally effective when there are no challenges.
Metacognition: Metacognition is thinking about one’s own thinking. It is the cognitive process of reflecting on what one knows and understands. When an individual realizes that they do not understand the solution to a problem they are using metacognition to come to that realization.	Better metacognition is associated with better learning. This occurs because metacognition allows the learner to identify and focus their studies on areas that are more poorly understood.
Retrieval: Retrieval is the active recall of information or a concept. The very act of recalling information enhances the memory of that information and makes it more available for future use. This is in contrast to restudy, which is the passive encoding of information or a concept (e.g., by reading or lecture) and does little to increase the future availability of information.	Retrieval strongly enhances the ability to again retrieve information in the future. Repeated retrieval enhances the durability of what was initially learned (encoded), so that it will be available for use at a later time
Spaced learning: Spaced learning refers to the insertion of distinct temporal gaps between learning episodes. This is in contrast to massed learning, which refers to learning with little or no time between learning sessions.	For a given total study time, spaced learning is more effective than massed learning for long-term retention. Longer interstudy intervals are more effective than shorter intervals. Spaced learning works for both learning new information and learning new motor skills.
Deliberate practice: Deliberate practice is designed to improve a specific area of one’s performance. It requires working at the edge of competency, is effortful, usually difficult, requires feedback, and focuses on areas of weakness or areas that can be improved. As soon as the learner attains an element of comfort and fluency with their current level of performance, they are then in a good position to reapply deliberate practice to attain the next level of performance.	Deliberate practice can be applied to any aspect of performance. It is effective for both cognitive skills and motor skills. It is fair to say that expertise will not be attained without the regular use of deliberate practice to one’s domain of performance.

The Take-Away

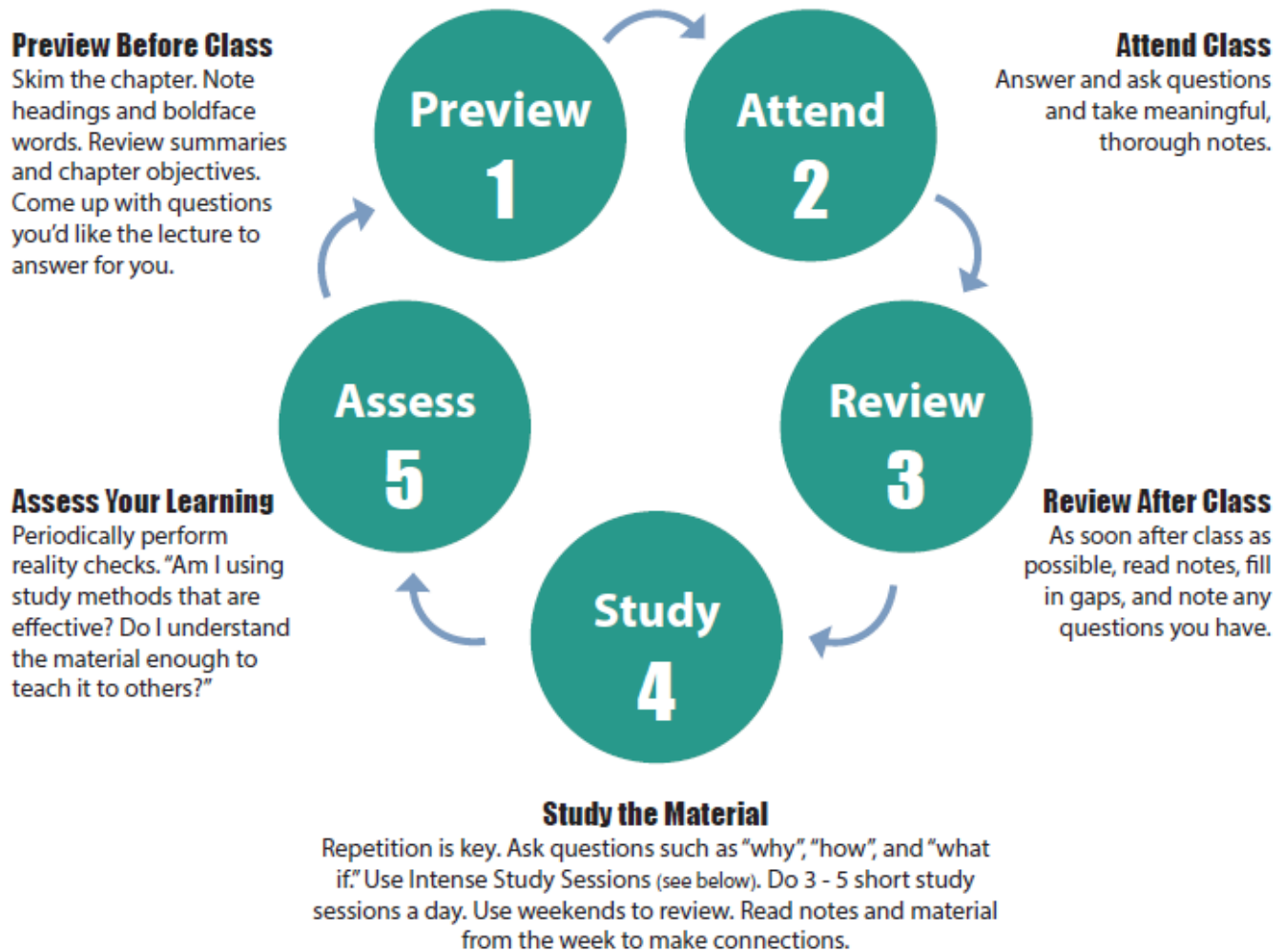
1. **Be the one in charge, embrace the notion of successful intelligence**
2. **Adopt active learning strategies, distill the underlying learning principles**
3. **Build the structure**



(Brown) “the most successful students are those who take charge of their own learning and follow a simple but disciplined strategy. You may not have been taught how to do this, but you can do it, and you will likely surprise yourself with the results. Embrace the fact that significant learning is often, or even usually, somewhat difficult. **You will experience setbacks. These are signs of effort, not of failure. Setbacks come with striving, and striving builds expertise.** Effortful learning changes your brain, making new connections, building mental models, increasing your capability. The implication of this is powerful: Your intellectual abilities lie to a large degree within your own control. Knowing that this is so makes the difficulties worth tackling.”

“Human intellectual development is “a lifelong dialogue between inherited tendencies and our life history”

A Good Template of Learning Structure (From Purdue U, Academic Success Center)



INTENSE STUDY SESSIONS

- | | | |
|----------------------------|-------------------|--|
| 1. Set a Goal | (1 - 2 minutes) | Decide what you want to accomplish in your study session |
| 2. Study with Focus | (30 - 50 minutes) | Interact with material – organize, concept map, summarize, process, re-read, fill-in notes, reflect, etc. |
| 3. Reward Yourself | (10 - 15 minutes) | Take a break – call a friend, play a short game, get a snack |
| 4. Review | (5 minutes) | Go over what you just studied |

Detailed “How to” Tips on <http://www.learningscientists.org/>

Sumeracki, M. Weinstein, Y. Six Strategies for Effective Learning. *Academic Medicine*. 93(4):666, April 2018

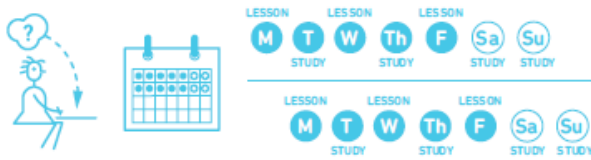
Six Strategies for Effective Learning

Megan A. Sumeracki, PhD, assistant professor, Psychology Department, Rhode Island College, and Yana Weinstein, PhD, assistant professor, Psychology Department, University of Massachusetts Lowell

All of the strategies below have supporting evidence from cognitive psychology and are highly relevant to medical students who need to learn vast amounts of information. For each strategy, we explain how to do it and point to the relevant literature. For more information and resources, visit the The Learning Scientists website.¹

1 PLAN OUT YOUR STUDY SESSIONS²

Spaced Practice



Space out your studying over time. Make a plan and stick to it!

Interleaving



Switch between ideas while you study. Don't study one idea too long!

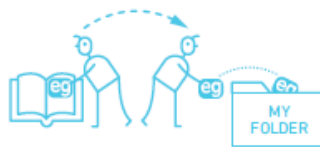
2 DURING STUDY TIME, MAKE SURE YOU UNDERSTAND THE MATERIAL³

Elaborative Interrogation



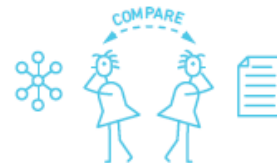
Ask yourself questions while you study about how and why things work, and then find the answers. Also try this with a partner.

Concrete Examples



Collect examples of abstract ideas, and make the link between the idea you are studying and each example.

Dual Coding



Combine words and visuals, and compare the two formats.

3 PUT AWAY YOUR CLASS MATERIALS AND WRITE OR SKETCH WHAT YOU KNOW⁴

Retrieval Practice



Put away your class materials, and write or sketch everything you know. Be as thorough as possible. Then, check your class materials for accuracy and important points you missed. You can also practice retrieval by taking practice tests. Ask your instructor or make your own and swap with a peer.