



BLUF

“There are known knowns; there are things we know that we know. There are known unknowns; that is to say, there are things that we now know we don't know. But there are also unknown unknowns – there are things we do not know we don't know.” – Donald Rumsfeld

- Empirical research into how we learn and remember shows that much of what we take for gospel about how to learn turns out to be largely wasted effort” (ix).
- “...the most effective learning strategies are not intuitive...” (ix).
- “It turns out that much of what we've been doing as teachers and students isn't serving us well, but some comparatively simple changes could make a big difference” (9).
- “...when learning is harder, it's stronger and lasts longer” (9).
- “Learning is stronger when it matters, when the abstract is made concrete and personal” (11).

Chapter 1: Learning is Misunderstood

- Learning means “acquiring knowledge and skills and having them readily available from memory so you can make sense of future problems and opportunities” (2).
- Brown, Roediger, and McDaniel identify three “immutable aspects of learning”:
 - “[T]o be useful, learning requires memory” (2).
 - “[W]e need to keep learning and remembering all our lives” (2).
 - “[L]earning is an acquired skill, and the most effective strategies are often counterintuitive” (2).
- “Learning is deeper and more durable when it's *effortful*” (3).
- “We are *poor judges* of when we are learning well and when we're not” (3).
- “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” (3).
- **Rereading text** and **massed practice** → preferred study strategies for most learners → least productive/effective (3).
 - Massed practice means “the single-minded, rapid fire repetition of something you're trying to burn into memory, the ‘practice-practice-practice’ of conventional wisdom” → ie. – cramming (3).
 - “Retrieval practice – recalling facts of concepts or events from memory – is a more effective learning strategy than review by rereading” → ie. – flashcards (3).
 - “Retrieval strengthens the memory and interrupts forgetting” (3).
 - “A single, simple quiz after reading a text or hearing a lecture produces better learning and remembering than rereading the text or reviewing lecture notes” (3).
- “Periodic practice arrests forgetting, strengthens retrieval routes, and is essential for hanging onto the knowledge you want to gain” (4).
- “When you **space out practice** at a task and get a little rusty between sessions, or you **interleave** the practice of two or more subjects, retrieval is harder and feels less productive, but the effort produces longer lasting learning and enables more versatile application of it in later settings” (4).
- “Trying to solve a problem *before being taught the solution* leads to better learning, even when errors are made in the attempt” (4).
- Brown, Roediger, and McDaniel allege that empirical research does not support the efficacy of preferred “learning styles” (i.e. – auditory, visual, tactile, etc.). Rather, they insist, learners should “‘go wide,’ drawing on all [their] aptitudes and resourcefulness” (4).
- Research suggests “extracting the *underlying principles or ‘rules’*...is better acquired through **interleaved** and **varied practice** than **massed practice**” (4).
- “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” (5).
- “All new learning requires a *foundation of prior knowledge*” (5).
- **Here is What I Know** - “Elaboration is the process of giving new material meaning by expressing it in your own words and connecting it with what you already know. The more you can explain about the way your new learning relates to your prior knowledge, the stronger your grasp of the new learning will be, and the more connections you create that will help you remember it later” (5).
 - “Putting new knowledge into a *larger context* helps learning” (6).
 - “...if you're trying to learn an abstraction, ...it's easier when you ground it in something concrete that you already know...” (6).

- Complex mastery occurs when learners “*extract the key ideas from new material and organize them into a mental model and connect that model to prior knowledge*” (6).
- “[F]ailure to meet a learning challenge is [not] an indictment of [one’s] native ability” (7).
- Employing “mental models that enable [learners] to reason, solve, and create” improves mastery and learning (7).
- Effective learning occurs when learners “see failure as a badge of effort and a source of useful information” – when they feel the subsequent “need to dig deeper or to try a different strategy” (7). Indeed, “[m]aking mistakes and correcting them builds the bridges to advanced learning” (7).
- Widely-held myths about learning:
 - “...if you expose yourself to something enough times...you can burn it into memory” (9).
 - If learning “is easier and faster, the learning will be better” (9). In fact, when learning is harder, it’s stronger and lasts longer” (9).
 - “[D]ogged, single-minded, practicing [something] over and over again until you’ve got it down” doesn’t work (9). In fact, “gains achieved during [such] massed practice are transitory and melt away quickly” (10).
 - Re-reading a text over and over leads to learning. No. In fact, rereading “has three strikes against it. It is time consuming. It doesn’t result in durable memory. And it often involves a kind of unwitting self-deception, as growing familiarity with the text comes to feel like mastery of the content” (10).
 - A student’s intentionality, lectures, and repetition do not, by themselves, lead to learning something well (12).
 - “[P]rior exposure [does] not aid later recall. Mere repetition [does] not enhance learning” (14).
- Question: How can we incorporate “memory action items” (actions taken without hesitation or thought) into our practice?
- “[A]ctive engagement...leads to durable learning” (11).
- **Spaced reading** is more effective than “multiple readings in close succession” (15).
- “Rising familiarity with a text and fluency in reading it can create an illusion of mastery” (15). Indeed, “repeated reading provides [only] the illusion of mastery of the underlying ideas” (16).
- “Being accurate in your judgment of what you know and don’t know is critical for decision making” and learning (16-17).
- “[E]ven the most diligent students are often hobbled by two liabilities: a failure to know the areas where their learning is weak...and a preference for study methods that create a false sense of mastery” (17).
- Knowledge vs. creativity is not an either-or proposition (18).
- “Mastery in any field...is a gradual accretion of knowledge, conceptual understanding, judgment, and skill” (18). It “requires both the possession of ready knowledge and the conceptual understanding of how to use it” (18).
- Testing – or **active retrieval** – “strengthen[s] memory” and “the more effortful the retrieval, the stronger the benefit” (19).
- “In effect, retrieval – testing – interrupts forgetting” (20). Other effective forms of retrieval – “low-stakes quizzing and self-testing, spacing out practice, interleaving the practice of different but related topics or skills, trying to solve a problem before being taught the solution, distilling the underlying principles or rules that differentiate types of problems” (21).

Chapter 2: To Learn, Retrieve

- “[A]n essential kind of learning...comes from reflection on personal experience” including “retrieving knowledge and earlier training from memory, connecting these to new experiences, and visualizing” and mental rehearsals (26-27).
- “[A] central challenge to improving the way we learn is finding a way to interrupt the process of forgetting” (28).
- “[P]racticing retrieval makes learning stick far better than reexposure to the original material” (28) → ie. - the **testing effect**
- “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.” This leads to “the brain act[ing] before the mind has time to think” – which leads to deeper learning and mastery (28-29).
- “The stronger one’s knowledge...the more nuanced one’s creativity can be in addressing a new problem” (30).
- “[M]assed studying (cramming) leads to higher scores on an immediate test but results in faster forgetting compared to practicing retrieval.” Indeed, “multiple [spaced out] sessions of retrieval practice are generally better than one” session (32).
- “When retrieval practice is spaced, allowing some forgetting to occur between tests, it leads to stronger long-term retention than when it is massed” (32).
- Brown, Roediger, & McDaniel believe scheduled quizzes work better than a single high stakes exam or pop quizzes (37-38).
- Instructor feedback on wrong answers to test questions “strengthens retention more than testing alone” (38).
- Briefly “delaying feedback...produces better long-term learning than immediate feedback” (39).
- “Tests that require the learner to supply the answer, like an essay or short-answer test ... appear to be more effective than simple recognition tests like multiple choice or true/false tests” (40-41).
- “[W]here more cognitive effort is required for retrieval, greater retention results” (41).
- “*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” (43).
- “Testing doesn’t need to be initiated by the instructor” (44). Self-testing is more effective than re-reading.