



## Make It Stick: The Science of Successful Learning

*Peter C. Brown , Henry L. Roediger III , Mark A. McDaniel*

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To most of us, learning something "the hard way" implies wasted time and effort. Good teaching, we believe, should be creatively tailored to the different learning styles of students and should use strategies that make learning easier. *Make It Stick* turns fashionable ideas like these on their head. Drawing on recent discoveries in cognitive psychology and other disciplines, the authors offer concrete techniques for becoming more productive learners.

Memory plays a central role in our ability to carry out complex cognitive tasks, such as applying knowledge to problems never before encountered and drawing inferences from facts already known. New insights into how memory is encoded, consolidated, and later retrieved have led to a better understanding of how we learn. Grappling with the impediments that make learning challenging leads both to more complex mastery and better retention of what was learned.

Many common study habits and practice routines turn out to be counterproductive. Underlining and highlighting, rereading, cramming, and single-minded repetition of new skills create the illusion of mastery, but gains fade quickly. More complex and durable learning come from self-testing, introducing certain difficulties in practice, waiting to re-study new material until a little forgetting has set in, and interleaving the practice of one skill or topic with another. Speaking most urgently to students, teachers, trainers, and athletes, *Make It Stick* will appeal to all those interested in the challenge of lifelong learning and self-improvement.

## Make It Stick: The Science of Successful Learning Details

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# From Reader Review Make It Stick: The Science of Successful Learning for online ebook

Ilib4kids says

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Similar book "How We Learn: The Surprising Truth About When, Where, and Why It Happens" which focus on history instead of giving practice tips

Ideas I learn most useful:

1. Learn more by testing than re-reading; re-reading create illusion of mastery.
2. Spacing and interleaving are more useful than sequential learning and mass practices.
3. Growth mindset is extremely important not only in learning, but in everything. Setback and mistakes are only ways to success. Do not afraid of them, as a way to judge your ability as so many people snare in this trap.
3. **Memory is available vs. Accessible** (Means what we have learned in the life time still stored in our memory, but not accessible at any given time. Memory need to be able accessible must have some cues in order to activate them)

px 2 primary learning principle: spaced repetition of key ideas; **interleaving** of different but related ideas.

p3 Claims we make in this book

1. Learning is deeper and more durable when it's **effortful**
2. We are poor judges of when we are leaning well and when we're not.
3. **Rereading text and massed practice ... least productive.**
4. Retrieval practice - recalling facts or concepts ..form memory is more effective than review by rereading. e.g Flashcards
5. Space out practice at a task and get a little rusty between sessions, or interleave of two or more subjects...produce longer lasting learning.
6. Trying to solve a problem before being taught the solution leads to a better learning.
7. The popular notion that you learn better when you receive instruction in a form consistence with your preferred learning style, e.g auditory learner is not supported.
8. Extracting the underlying principles or rules that differentiate types of problem...This skill is better acquired through interleaved and varied practice than massed practice. e.g interleaving practice at computing the volumes of different kinds of geometric solids.
9. Build mastery when use testing as a tool to identify and bring up areas of weakness.
10. **Elaboration** is the process of giving new material meaning by expressing it in your own words and connecting it with what you already know.
11. People who learn to extract the key ideas from the new material and organize them into a **mental model** and connect that model to prior knowledge show an advantage in learning complex mastery.
12. It is true that we start life with gift of our genes, but it's also true that we become capable through the learning... In other words, **the elements that shape your intellectual abilities lie to a surprising extent within your own control...** Striving and setbacks...are essential if ..surpass your current level...Making mistake and correcting them build the bridges to advanced learning.

p15 Rereading (rising familiarity with text and fluency ..) can create an **illusion of mastery**

chap2 To learn, to retrieve

chap3 Mix up your practice (Spaced practice; interleaved practice; Varied practice)

p46 The myth of Massed practice: ..it feel like a productive strategy, ...but most of material will be long forgotten.

p58 Book learning is not enough in these cases; actual hands-on practice is needed.

p62, it's all there: **retrieval, spacing, interleaving, variation, reflection, and elaboration.**

p65 In **interleaving**, you don't move from a complete practice of one topic to go to another. You switch before each practice is complete.

p66 One difference, between those who do and don't (learning from experience) is whether they have cultivate the habit of reflection. **Reflection** is a form of retrieval practice. (what happened? What did I do? How did it work out?), enhanced with elaboration (What would I do differently next time?) --my comment: reflection and elaboration I think is most critical aspects in learning well.

Chap3 Embrace difficulties

Desirable difficulties.: they trigger encoding and retrieval processes that support learning, comprehension, and remembering. If however, the learner does not have the background knowledge or skills to respond to them successful, they become undesirable difficulties. p98

p72 How Learning Occurs: Encoding; Consolidation; Retrieval.

p87 **Generation**: the act of trying to answer a question or attempting to solve a problem rather than being presented with information or the solution is known as generation.

Chap4 Avoid illusion of knowing

Cause of illusion and memory distortions p109

Hunger for narrative; Imagination inflation; Suggestion; interference; curse of knowledge; feeling of knowing; Fluency illusions; social influence; false consensus effect.

Chap5 Avoid illusion of knowing

Chap6 Get beyond learning styles

p141 On any list of difference that matter most for learning, the level of **language fluency and reading ability** will be at or near the top.

learning styles

p143 Belief in the learning styles credo is pervasive...It is not supported by science, and it instills a corrosive, misguides sense of diminished potential

Neil Fleing VARK

Honey and Mumford's Learning Styles Questionnaire

p145 The premise of learning styles is that we learn better when the mode of presentation matches the particular style in which an individual is best able to learn. This is the critical claim...In 2008, Cognitive psychologist Harold Pashler... were commissioned to conduct a review to determine whether this critical claim is supported by scientific evidence... The answer is NO...Moreover, their review showed that it is more important that the mode of instruction match the nature of the subject being taught; visual instruction for geometry and geography...

Intelligence

Fluid intelligence; Crystallized intelligence

p147 Howard Gardner 8 multiple intelligence

p150 Robert Sternberg 3 part of intelligence: Analytical; Creative; Practical

Chap7 Increase your abilities

Carol Dweck Growth Mindset

Anders Ericsson Deliberate Practice"

Memory Cues

Chap8 Make it stick

### Learning tips for students

Practice retrieving new learning from memory; Space out your retrieval practice; Interleave the study of different problem types; Elaboration; Generation; Reflection; Calibration; Mnemonic Device.

Tips for teachers p225--239

p228 Bloom's taxonomy classifies cognitive learning in 6 levels: Knowledge; Comprehension; Application; Analysis; Evaluation; Synthesis

p252 We have talked throughout this book about learning, not about education. The responsibility for learning rests with every individual, whereas the responsibility for education rests with institution of society. Education embrace the a world of difficult questions.

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### ????? ??????? says

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### Nelson Zagalo says

"Make it Stick" é um livro de divulgação científica que procura dar a corpo a um conjunto de teorias desenvolvidas por dois professores de psicologia (Henry L. Roediger e Mark A McDaniel) que ao longo de várias décadas estudaram o modo como criamos memórias. O terceiro autor (Peter C. Brown) é especialista em storytelling, e contribuiu aqui especificamente para o desenho da apresentação dos resultados desse estudo. A ideia central de toda a teorização que percorre todo o discurso apresentado no livro é o da Recuperação de Memórias ("Memory Retrieval"), de que já aqui tinha falado a propósito da leitura dos Cânones. Uma técnica suportada por dezenas de estudos empíricos que demonstram a sua relevância e pervasividade no largo espectro da aprendizagem. O conceito assenta na lógica biológica que regula a construção de memórias a nível neuronal.

Assim, precisamos de primeiro compreender que as memórias que possuímos são conjuntos de associações de nós neuronais, de ligações entre neurónios. Quando experienciamos algo — ao vivo, lendo, vendo, ouvindo — o nosso cérebro produz novas ligações entre neurónios que dão conta de imagens mentais que nós chamamos quando queremos recordar alguma coisa. Ou seja, quando jogamos xadrez e pegamos no cavalo, o nosso cérebro recupera a ideia de que este apenas se pode movimentar em L, e deste modo ajudamos a realizar a ação de movimentação da peça no tabuleiro. Nós podemos recordar a imagem mental do movimento em L, porque anteriormente a isso nos foi ensinado — explicado em palavras, ou visto em ação. A questão que se coloca, é, como é que nos lembramos que o cavalo se deve mover em L? E é a esta questão que o livro responde.

Não basta alguém explicar-nos em palavras ou atos, como se move o cavalo em L. Para que no fim-de-semana seguinte a ter aprendido a jogar, eu possa saber, ou seja aceder à memória do movimento do cavalo de xadrez, eu preciso de "exercitar" essa mesma memória, preciso de a recuperar várias vezes durante a semana. É importante que dentro da minha cabeça eu continue a "chamar" a memória, para manter vivas as relações de nós neuronais que edificam a imagem mental do movimento do cavalo. Se ao longo da semana

não o fizer, as ligações neuronais criadas aquando da explicação de como se joga acabam por se desfazer, ou seja, acabarei por simplesmente esquecer.

Se o chamar da memória é importante, existe algo ainda mais importante, o modo como é chamada, ou dito de forma mais literal, recuperada. “Make It Stick” dedica-se fundamentalmente a explicar esse processo de recuperação, explicando os modos como podemos tornar as memórias mais fortes e sustentáveis no tempo. E esses modos, os melhores, não são aquilo que muitos de nós esperávamos, não são aquilo que nos ensinaram durante décadas de escola, não são nem atrativos nem intuitivos. O melhor resumo, surge na explicação de uma professora quase no final do livro:

"Eu não consigo dizer-lhe quantas vezes os alunos vêm ter comigo, e me mostram os seus livros com sublinhados e destacados em quatro cores diferentes. Então eu digo-lhes: "eu posso dizer que vocês têm trabalhado imenso e que realmente querem ser bem sucedidos nesta cadeira porque vocês tem azul e amarelo e laranja e verde marcados nos vossos livros". Mas é também quando tenho de lhes dizer: “que todo o tempo gasto com o livro depois da primeira leitura foi um desperdício.” E eles dizem: "Como é isso possível?" Ao que respondo: "O que vocês tem que fazer é: vocês leem um pouco, e depois têm que se testar a vós mesmos”, mas eles não sabem como fazer isso.

Então eu modelo as aulas para que possam fazer isso mesmo. A cada cinco minutos, ou assim, eu jogo uma pergunta sobre o material que acabámos de falar, e eu posso vê-los a começar a olhar para as suas notas. Mas eu digo: "Parem. Não olhem para as vossas anotações. Basta um minuto para pensarem sobre isso vocês mesmos.” Eu digo-lhes que os nossos cérebros são como uma floresta, e que a memória está lá nalgum lugar. Vocês estão aqui, e a memória está ali. Quanto mais vezes vocês fizerem o caminho até essa memória, mais evidenciado ficará esse caminho, de modo que na próxima vez que vocês precisarem dessa memória, vai ser muito mais fácil encontrá-lo. Mas, assim que vocês olharem para as vossas notas, vocês vão curto-circuitar esse caminho. Vocês deixam de explorar o caminho, porque esse já vos foi dito. " Mary Pat Wenderoth, Professora de Biologia, Universidade de Washington

Criar memórias é criar caminhos e exige esforço, repetição e dedicação. Ler um livro, ver um filme, assistir a uma aula são apenas pontas de icebergues, existe toda uma quantidade de trabalho de construção da memória que cada um precisa de fazer, que mais ninguém pode fazer por nós. E o que estes estudos nos vêm dizer é ainda mais dramático, já que não basta deixarmo-nos expor repetidamente à informação. Ou seja, reler e reler um texto, ou rever e rever um filme, ou assistir a todas as aulas. Se não existir um trabalho de chamar a memória que ilumine o “caminho” até ela, o simples facto da informação nos ser apresentada não ajuda a solidificar a memória em si, ainda que contribua para durar até ao dia seguinte, podendo contribuir para a falsa ideia de que já memorizámos.

Deste modo o que Henry L. Roediger e Mark A McDaniel nos dizem é que as as práticas denominadas de “marranço”, que continuam a ser professadas desde sempre e até aos nossos dias não funcionam. Os vários estudos realizados demonstram que os alunos que realizaram pequenos testes várias vezes depois de uma leitura única, face aos que releeram várias vezes o mesmo material, são imensamente mais efetivos a recordar a informação.

Esta abordagem vem assim uma vez mais apoiar as práticas sustentadas em técnicas interativas, ou de jogos, de entre os mais famosos, os conhecidos Quizzes, mas quase todos os outros modelos. Aliás, é exatamente este o modelo proposto pela Escola Virtual em Portugal, que pega nas matérias escolares, e cria cenários hipotéticos que questionam os alunos sobre as matérias. Não querendo fazer aqui defesa promocional da plataforma, tenho de dizer que é excelente, porque um dos maiores problemas que um aluno enfrenta no seu estudo é a falta de uma base de perguntas sobre a matéria. Podendo ter uma plataforma na qual essas perguntas estão disponíveis e com claro feedback, algo essencial a uma efetiva aprendizagem, fica apenas a faltar o investimento do esforço do aluno.

Mas não queria quedar-me pelos testes e quizzes, mais ainda tendo sido eu desde há muitos anos um acérrimo crítico de exames e testes escritos. Aceito que eles servem a comparação, nacional e internacional, necessárias, mas não gosto particularmente do método de avaliar alguém por perguntas escritas, prefiro claramente abordagens projetuais, ou reflexivas e elaborativas como a escrita de ensaios. As razões porque não gosto começam desde logo pela pressão exercida, já que o teste só pode acontecer num momento concreto, e é de possibilidade única, ora o ser humano aprende essencialmente por imitação e tentativa e erro, que são formas de aprender no tempo, iterativas e interativas. Por outro lado, os testes condicionam a aprendizagem para a matéria em modo afunilado. Ou seja, aquilo que os alunos fazem enquanto estudam, releiam ou façam quizzes, é memorizar factos para poder debitar, quando aquilo que nós queremos é que a pessoa memorize esses factos para os articular com outros, para que construa e não apenas recite. Não é por acaso que Henry L. Roediger e Mark A McDaniel começam por enfatizar fortemente os testes, e os elevam a ferramenta de eleição para o estudo e aperfeiçoamento do ato de memorização, mas quando mais na parte final do livro começam a tentar aplicar este modelo à educação, acabam por citar a Taxonomia de Bloom (ver imagem).

[imagem]

Taxonomia de Bloom, revisão de 2001

Contudo, não podemos deixar de reconhecer que o objetivo deste livro, ao contrário do trabalho de Bloom, não são as práticas educativas mas o dar a conhecer de ferramentas e processo que nos permitem memorizar. O que na verdade, e olhando à pirâmide de Bloom, temos de aceitar como vital para tudo o resto. Não é possível criar sem deter conhecimento sobre o que se pretende criar. Assim como todas as restantes categorias que delineiam a nossa inteligência, todas precisam da base, da presença de memórias de factos, que possam ser recordadas no momento certo para agir.

Assim tenho de dizer que o livro vai mais longe do que a simples defesa do quizzing. Os autores apresentam múltiplas técnicas no livro, que se podem encontrar resumidas no último capítulo. Dessas, as três primeiras dirigem-se claramente ao quizzing, mas são passíveis de ser adaptadas a qualquer outro modelo, sendo que são as mais efetivas no processo de memorização: Recuperação, Espaçamento e Intercalação.

### 1. Recuperação

Práticas de recuperação de informação por meio de testes de perguntas (quizzing). Em vez de reler a informação, ler uma vez, e depois realizar testes sucessivos sobre a matéria. Em vários estudos realizados, os grupos que releram esqueceram 50% do que aprenderam, enquanto que os que realizaram apenas uma leitura, seguida de testes, investindo o mesmo tempo, esqueceram apenas 13%.

### 2. Espaçamento

Espaçar as sessões de recuperação, deixando espaço entre estas para esquecer. Os autores não referem, mas isto está baseado nas questões cognitivas da Atenção. O facto de espaçarmos a aprendizagem permite que o foco da atenção sobre a informação se exerça mais vezes, uma vez que o foco da atenção não se sustenta muito tempo sobre o mesmo tipo de estímulos.

### 3. Intercalação

Alternar os temas em que se está a trabalhar. Contra-intuitivo, porque torna a aprendizagem mais difícil, mas é exatamente por a tornar mais difícil que se torna mais eficaz em termos de memorização. Os autores apresentam vários estudos que demonstram claramente a eficácia da intercalação, que se pode fazer entre disciplinas, ou entre matérias de uma mesma disciplina.

Indo para além dos testes de perguntas, a dupla de psicólogos segue Bloom e apresenta práticas muito menos coladas à voragem métrica dos testes, mais adaptadas aos domínios que falava acima de projeto e ensaio, para o que propõem então outras três técnicas: Elaboração, Geração e Reflexão



התאמה בין התוכן לרמת היכולת של הלומד. לדוגמה, אם התוכן מורכב מדי, ייתכן שהלומד יתקשה להבין אותו.

### 2. Space out your retrieval practice

מחקרים מראים כי שיטת הריבוי (retrieval practice) מסייעת בהעברת מידע מהזיכרון הקצר לזיכרון הארוך. שיטת זו כוללת שימוש בשיעורי מבחן קטנים, המיושמים באופן שוטף במהלך תהליך הלמידה. שיטת זו מסייעת להערכת היכולת של הלומד, ולשיפור היעילות של הלמידה.

### 3. Interleave the Study of different problem types

שיטת הריבוי (retrieval practice) מסייעת בהעברת מידע מהזיכרון הקצר לזיכרון הארוך. שיטת זו כוללת שימוש בשיעורי מבחן קטנים, המיושמים באופן שוטף במהלך תהליך הלמידה. שיטת זו מסייעת להערכת היכולת של הלומד, ולשיפור היעילות של הלמידה.

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### 4. Elaboration

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### 5. Generation

שיטת הריבוי (retrieval practice) מסייעת בהעברת מידע מהזיכרון הקצר לזיכרון הארוך. שיטת זו כוללת שימוש בשיעורי מבחן קטנים, המיושמים באופן שוטף במהלך תהליך הלמידה. שיטת זו מסייעת להערכת היכולת של הלומד, ולשיפור היעילות של הלמידה.

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### 6. Reflection

שיטת הריבוי (retrieval practice) מסייעת בהעברת מידע מהזיכרון הקצר לזיכרון הארוך. שיטת זו כוללת שימוש בשיעורי מבחן קטנים, המיושמים באופן שוטף במהלך תהליך הלמידה. שיטת זו מסייעת להערכת היכולת של הלומד, ולשיפור היעילות של הלמידה.

### 7. Calibration

שיטת הריבוי (retrieval practice) מסייעת בהעברת מידע מהזיכרון הקצר לזיכרון הארוך. שיטת זו כוללת שימוש בשיעורי מבחן קטנים, המיושמים באופן שוטף במהלך תהליך הלמידה. שיטת זו מסייעת להערכת היכולת של הלומד, ולשיפור היעילות של הלמידה.

### ???? ??

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practices.

Applying these learning techniques informed by the hard science of cognitive psychology and learning theory revolutionized my study habits and dramatically improved my learning outcomes.

I remember asking my professor "why in the fuck didn't they teach us this at the beginning of the degree? I would have had better test scores and information retention with much less time and energy spent studying". He a looked back at me with the grim tired face of someone who had done battle with university bureaucrats for the better part of two decades and he said "if you manage to figure that out let me know".

Anyway, that's called counterfactual thinking (e.g. if I only knew then what I know now etc.) and it's a classic cognitive distortion, one of many maladaptive or counter productive ways of thinking identified in cognitive behavioral therapy, and it's pretty much a giant waste of thinking.

Anyway, the important point being that the findings of cognitive psychology and learning theory are like gold for people who teach, or who for people who really need/want/love to learn, or for people who are just plain curious about how the mind works.

If there were a book out there that was fun to read and that distilled all of these important findings and ideas into a potent short form, wouldn't you want to rush right out and get it? If the answer is yes, then I've got great news for you. Make It Stick is exactly that.

So if your response is "sure, I'll put that on my huge stack of reading that I'd like to do but probably won't", than I'd at least like to give you some of the key ideas.

Cognitive Multipliers:

At this point in my life I feel comfortable enough with my masculinity to admit that I used to play Dungeons & Dragons. That being said, I think I'd like to take this opportunity to come out of the closet and admit to my friends family and to the world that, at age 47, I still spend way too much time playing a turn-based computer war game called Civilization.

Anyway, in civilization there's this really important core concept called cultural multipliers. They are these technologies that you can develop that don't just add to the power of your civilization, they multiply the power of your civilization.

Well it turns out that your brain has somewhat equivalent little hacks called cognitive multipliers. They are simple little cognitive reframes and habits that can literally multiply your learning ability. The book is all about cognitive multiplayers. Here's a short list to (hopefully) spark your curiosity.

1: Embracing a growth mindset:

Mindset is a simple idea discovered by Stanford psychologist Carol Dweck.

In a fixed mindset, people believe their basic qualities, like their intelligence or talent, are simply fixed traits. They spend their time trying to demonstrate their intelligence or talent instead of developing them. They also believe that talent alone creates success without effort.

In a growth mindset, people believe that their most basic abilities can be developed through hard work. This view engenders a love of learning and resilience essential for accomplishing just about anything of value.

Mindset all boils down to the following. Those who attribute failure to lack of innate ability become hopeless

in the face of challenges. Those who attribute failure to insufficient effort double down and try harder in the face of challenges. Challenges are seen as opportunities to grow and improve skills.

Adopting a growth mindset is probably the single most important cognitive multiplier. It sounds easy but it takes a lot of self monitoring in order to ferret out and replace all the subtle little ways we all think fixed.

2: practicing like an expert:

It turns out that the effort of retrieving knowledge strengthens its staying power, and enhances your ability to retrieve it in the future. The authors advise periodically testing and strengthening new knowledge through self testing. The book goes into extensive detail about what the very best ways to self test are. So get it and read it if you want to know and trust me you do.

3: constructing memory cues:

The Method of loci (loci is Latin for "places") is a mnemonic device popular with ancient Roman and Greek orators (they needed it because didn't have power point back then).

Basically, it's a method of memory enhancement which uses visualization to organize and recall information.

In this technique you memorizes the layout of a location with a lot of different discrete places, like a street that you walk down a lot.

When you're trying to remember a set of items (like cards in a deck) you mentally "walk" through the location and commit item to each one of the places " e.g. the ace of clubs is by the Starbucks, the 3 of diamonds is by the old Blockbuster, the 5 of spades is by the gas station. Retrieval of items is achieved by imagining walking back through the place, allowing it to activate the desired items.

It sounds like B.S. but it works. If you've ever seen those dudes who can memorize like four decks of cards, this is how they all do it.

Liberal using mnemonic devices such as the method of loci and using other ways of associating new knowledge with vivid and unusual mental imagery is highly effective (for reasons described in detail in the book).

Roy G. Biv is the classic mnemonic for remembering the color spectrum. You imagine a guy in a rainbow colored outfit who's name is Roy G. Biv. It's actually an anagram for: Red, Yellow, Green, Blue, Indigo, Violet. It's lame as hell, but it works.

In anatomy, the sagittal plane is the vertical plane dividing the body into right and left halves. My anatomy instructor told us the STUPIDEST but extremely effective mnemonic device for remembering it, and I will never forget it.

You hold out you hand like you're shaking hands, and with a vertical up and down karate chop gesture you say "sagittal to meet you". I know it's asinine, but it works. And those types of devices tend to be extremely effective in general.

4: elaboration and personalization:

Elaboration is the process of finding additional layers of meaning in new material. Its what's meant when we say "let's unpack that idea".





is completely research-based. If you want to learn how to be a better learner, or to help others learn how to be better learners, this is a must-read. A cognitive psychologist friend introduced me to it by gleefully saying, "I have been replaced by a book." Indeed. This is the best book on the science of learning I have ever encountered. I would give it 6 stars if I could.

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## **John Martindale says**

I am an audiobooks junkie and often soon after I finish a book, I go to the computer to write a review, but my mind feels completely void—it seems like I completely forget all I just heard, even the fascinating tidbits. All I feel left with is an impression concerning whether I liked the book or not. Since there is this mental blockage, most of the time I just don't write much of a review and consider those things I wanted to share, lost. Most of my life it has seemed the majority of what was imprinted in my mind was written with disappearing ink.

But thank heaven, I download this audiobook "Make it Stick"!! The authors taught me that my initial blankness and difficulty recalling, is actually normal and is an important part in the learning process. That is, if I am diligent to search the recesses of my mind until I recall some of the content. Indeed it's this difficult act of retrieving, that will help cement it in our brain. An example a teacher gave her students was how our mind is like a forest, and the information is lost somewhere in it. The first time we go looking for it can be frustrating and difficult. But the next time will be easier and also will begin to form a trail, making it easier to find our way to the information in the future.

One of my biggest hindrances to learning has been my foolish wish that learning might be easy—a stroll through a park. I've wanted to be able to be passive recipient, merely reading or listening, exerting no effort beyond this. But indeed, as the authors point out, merely listening or reading and re-reading material, though giving a sense of familiarity with it, will only result in the illusion of knowledge. We will feel like we know something, but there is no way to know what we actually don't know, unless we're quizzed or questioned. The authors make it clear that re-reading, listening again to a lecture and reviewing our notes, though it may help up past a test the following day, will not result in long term knowledge or mastery. So yes, as I mentioned, if we want it to stick, we must recall, recall, recall. When we find it difficult, we must resist the temptation to just going back and glancing again at what we previously read, for this would be merely re-reading. We must first try hard to remember and only after this go back to the book/answers/notes and fill in the blanks and make sure we recalled correctly. But it's not merely searching the crannies of the mind and located something, we must reflect on it after finding it. We need to elaborate on the concepts, expressing them in our own words and thinking up examples and analogies, also we should seek to relate and connect the material with our past knowledge. All of this may seem like hard work, but the authors mentioned if learning ain't hard, it's like writing in the sand, it will all be washed away.

Even though this requires effort. It is exciting to know that one of the best ways of learning is to actually seek to recall and reflect on the material. And just think, this can be done anywhere, it's like I can be learning and encoding things I had read, throughout the day.

The authors point out, how testing, is not so much merely for making sure we learned the material, but testing is an excellent way to learn it. There was a study they mentioned in which one group spent an amount of time cramming, and another spent the same amount of time recalling and quizzing themselves, and then after an extended period of time, when tested, the crammers lost 50% while the recallers only lost 13% of the information they learned. The same amount of time was spent and recalling was obviously far more effective. This is encouraging.

They also wrote a good deal about interweaving (I think that is what they called it.) examples would be things like the batter in baseball will do better if he practices with all kinds of pitches, rather than mastering curve balls, fast balls, etc... one at a time. Though the latter will seem more productive, it will give the illusion of mastery. The authors gave the example of those learning to associate artist names with their paintings, and how it's best to skip around, instead of spending much time on anyone. I suppose learning in school is often like A-B-C-D-E-F-G, but real life is F-A-C-D-G-B-E.

The Authors wrote on the importance of understanding the growth mentality, instead of thinking intelligence is static. If kids are told they're smart or that they're "a natural" it can have disastrous results, but if they're praised for diligence and hard work, this will often bear good fruit. People need to understand the brain is plastic and no matter the amount of intelligence we were endowed with, we can through tons of practice and work, master many, many things.

But yeah, there is more, but the review is long enough. I will mention I employed the concepts they taught me as I went through the book. I likely spent almost as much time reflecting on it (out loud) while on walks, as I did listening to the book. And yes, I think reflecting on it several hours benefited me much more than merely re-listening to the audiobook.

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### **Patrik says**

A very convincing and readable book about how to better learn and, as an extension, how to better teach. Two psychologists and (thankfully) one writer present the latest research on learning and, in so doing, refutes some of our most popular learning techniques (such as 'practice, practice, practice' and my favorite 'read and reread'). At the end of the book, the following eight concrete techniques are offered:

1. **Retrieving** - practice retrieving new (and old) learning (self-quizzing).
2. **Spacing** - space out your retrieval practice, leave time to forget in between practice sessions.
3. **Interleaving** - alternate working on different problems facilitates spacing and forgetting (making learning more difficult, which improves learning).
4. **Elaboration** - try to find additional layers of meaning in the new material.
5. **Generation** - attempt to answer a question or solve a problem before looking at the answer (experiential learning).
6. **Reflection** - a combination of retrieval practice and elaboration that adds layers to learning new material. Ask your self questions.
7. **Calibration** - to avoid various cognitive illusions, use an objective instrument to adjust your sense of what you know and don't know.
8. **Mnemonic devices** - build memory palaces to help yourself retrieve what you have learned.

I will aim to incorporate several of these ideas into my courses - mainly through (1) generation, (2) elaboration, and (3) retrieval practice through frequent, predictable, low-stakes "testing" (including interleaving). I will not be promoting mnemonic devices...

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### **Elizabeth Theiss says**

From the perspective of a professor with a good 20 years of experience, this book is a gem. The authors use research to demonstrate how students learn best and how teachers can structure courses to facilitate student learning. While I've read many books on teaching, few are as helpful as this one.

For example, frequent recall of recent information cements learning. Teachers can help by providing frequent low stakes quizzes that require students to utilize Bloom's taxonomy. The authors provide basic principles and case studies of each principle in practice.

Well worth reading for teachers and for students working at becoming more effective learners.

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## Alex Linschoten says

In 'Make it Stick', the authors explain how to study, how to learn things for long-term retention, and how to tweak the school experience to encourage retention. The authors strive to make examples practical and applicable. Spaced-repetition software is never mentioned in the book -- in fact technology really isn't the focus -- but it's possible to read it as a love letter to Anki. (This would have been five stars but for it being slightly too long.)

Some key things I learnt:

- testing recall helps cement memories
- pure repetition (either rereading something or repeating a concept out loud multiple times) doesn't work, and could even harm you by giving a false sense of confidence/familiarity with the material.
- apparently some of the research also shows that a delay in the feedback (i.e. you don't get to find out how you did on the test at the exact same time as taking the test) is preferable to immediate feedback, even w/r/t types of skills (motor skills e.g.) that you'd think would reward immediate feedback.
- tests don't have to be digitally produced
- production tests (i.e. you have to supply the answer out of thin air) offer greater benefits than multiple-choice tests, but even multiple choice testing offers benefits when compared with no testing.
- the ideal situation is one in which you are 'reaching' in some way -- i.e. the test should be hard. If the test is easy, it's probably not delivering that much benefit.
- difficult tests (where you have to 'reach' further) help cement memories better than easy tests.
- interleaved testing is better than massed testing -- which is to say that instead of siloing all your biology tests together, doing them, then moving on to physics, then moving on to French (for example), you should really mix it all up so that you are switching context. It will be harder and much more frustrating, but the research suggests you'll emerge in the long-term with a much more flexible grasp of the materials.
- building scaffolding and mental maps is important for learning -- without the basic scaffolding of a subject, it's hard to hang new concepts and to expand your knowledge.

Again, not all of this was new to me, and it won't be to many readers, but this was a useful reminder. I shall be tweaking my learning regimen accordingly.

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## Jeremy says

If only I had known... So I'll let you in on the secret. EVERYTHING you need to know is contained in Chapter 8. The final chapter of the book, naturally. So skip to page 200 and save yourself a LOT of time wandering aimlessly through the groves of academe. Not that there isn't viable information in the preceding seven chapters, mind you, but it's a long slog of background before getting to the good stuff.

I suppose they had to do *something* to make it more than a pamphlet.

Trust me. Read Chapter 8, and then - if you feel so inclined - you can go back for the tedious build-up. But Chapter 8 really does have some good - and practical - information on how to learn (and how "quick-fixes" like cramming and rote memorization are not true fixes at all).

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