Make It Stick (2014) by *Peter C. Brown, Henry L. Roediger III, Mark A McDaniel*

Planning Summary by Helen Reynolds https://itsalearningcurve.education/

Content	Do This/Remember This
1: Learning is Misunderstood: *Immutable* features of learning: 1.requires memory, 2. continues all our lives 3. is an acquired skill (but methods can be counterintuitive). We are poor judges of what **doesn't** work → cramming/re-reading/teaching to learning styles. What **does** work = retrieval practice (RP)/spaced practice/interleaving/varied practice/trying a problem first /extracting underlying principles/elaboration for meaning/putting knowledge (K) in wider context + needs foundation of prior knowledge (PK). Get **advantage in learning** complex mastery if you: extract key ideas → organize into mental model → connect to PK. **Not** well understood that: exposure ≠ burn it into brain/easy ≠ good/over & over till got it down ≠ permanent/ time spent rereading ≠ mastery/firehose lectures ≠ learning/intention to learn ≠ success/ repetition ≠ K. Rumsfeld: without testing there will be unknown unknowns. Mastery = gradual accretion of **K** + conceptual understanding (U) + judgement + skill.	•
2: To Learn, Retrieve: Forgetting curves: forget 70% what we just heard/read v. quickly, 30% more slowly. Upset forgetting with retrieval (testing effect), effective if repeated + spaced. Unhelpful conflation of developing K with memorization/rote learning/mindless/uncreative/ lack of imagination → NOT true. Testing effect research in labs: 1917, 1939, 1967, 1978, in a classroom 2005-7 (by authors + Patrice Bain – see Powerful Teaching) - no stakes retrieval testing improved by grade level/92% vs 79% for not tested, effect continued for 8 months. Same effect seen at university level. Feedback (FB): some evidence delayed FB beneficial, Types of RP: generating answers better than recognition (multiple choice, T/F). Testing effect → better transfer of K, retrieval of not tested material. Student attitude to RP: dislike idea of RP, like results (don't have to cram), use results of RP to re-study weak areas. Other effects: increased prep + attentiveness + confidence in long-term, reduced test anxiety.	•
3: Mix Up Your Practice: Tossing beanbag research – practice at 2ft/4ft bucket = better results for 3ft bucket than 3ft alone. Mixing it up *works* BUT more effortful/don't see gains so easily or quickly/feels slower. Spaced practice (SP) = consolidation in long-term memory (LTM) = memory traces strengthened + given meaning + connected to PK. Interleaved practice (IP) = mixing subjects, gains as in SP. Varied practice (VP) = like beanbags, mixing up contexts = better consolidation. Discrimination *v. important skill* for interrogating problem space, needs IP /VP to develop underlying concepts that unite/differentiate = conceptual knowledge (CK) that links factual K. Medical research: to improve you need to DO it, not just read about it. Massed practice → 'momentary strength' vs. **SP/IP/VP** → 'underlying *habit* strength', habits = repetition, beware familiarity trap. VP builds broad schema → better ability to apply to novel situations.	•
4: Embrace Difficulties: Short term impediments → **stronger** learning = desirable difficulties (Bjork & Bjork), feeling confident ≠ demonstrating mastery – must DO it. Learning = encoding (memory traces in short-term memory (STM)) + consolidation (strengthening into limitless LTM brain replays/fills in blanks/ gives meaning/ links to pre-requisite PK), retrieval (enables association with diverse set of clues). Retrieval capacity = how easily recalled depends on context, recency of use, number + vividness of cues. *Some* forgetting essential for new learning, material associated with new clues. Problem: easier to retrieve = less benefit to retention. **Effortful/**slower) *SP/IP/VP* **better**= requires you to reload/ reconstruct from LTM, interrelated skills/K fuse into 'mental model' = highly efficient, develops more cues + better conceptual U/discrimination/induction effort is why priming works. Surprising findings: effort due to font/focus/mismatched lecture notes = better learning. **Effortful** *generation* = mild (filling in blanks), medium (short answer), hard (essay, multi-step problem). **Effortful** *reflection* = what are key ideas/examples/links to my PK or key skills/what did I do well/need to do better – hits many aspects of learning very beneficial. History: B.F.Skinner 'errorless learning' NOT helpful, S do NOT learn errors if they're corrected. S more resilient/less anxious/do better on tests if taught that learning/changing brain involves making mistakes. Goal from failure = dauntless effort despite risks to find what works/doesn't work. **Undesirable** difficulties: tasks where S doesn't have PK/skills/language/ fluency/not possible.	•
5: Avoid Illusions of Knowing: Monitoring own thinking = **metacognition** BUT can be led astray by illusions/cognitive biases/stories. Become expert→ recognize competence/judge ourselves accurately/adopt effective strategies/monitor progress. Kahneman (Thinking Fast & Slow): System 1 (fast/ intuitive/ deft /prone to illusion/ survival reflex/quick conclusion), System 2 (controlled/ conscious analysis/ reasoning/ choice/ self-control). **Illusions** & **memory** distortions: we dislike ambiguity/arbitrariness (particularly in personal life) = search for explicatory narrative → need meaning → framework for new experiences to fit. **Main illusions**: comprehension/competence/remembering (what is implied/ vivid imaginations = memory, suggestion/priming, interference/conflating events). **Other illusions**: feeling of	•

knowing/fluency illusion, social influence (peers affect memory)/false consensus effect, 'flashbulb moments'/overconfidence (but can change). Mental models: Ts often suffer 'curse of knowledge' (underestimate how long others will take to learn what we know), linked to hindsight bias, due to number/complexity of Ts mental models. Dunning-Kruger: unskilled lack skills to improve/overestimate competence (due to lack of negative feedback). Illusion/misjudgments →student-directed learning problematic, unlikely to employ strategies that work. Tools to calibrate what you're learned: testing, peer instruction (Mazur), *not* using cues like familiarity/ fluency, getting authentic feedback, use the mistakes you make wisely.	
6: Get Beyond Learning Styles: Differences between learners. Differences that **matter**: how you see yourself/your capabilities → how much effort you put in/tolerance for risk/ perseverance with difficulties, your language fluency/reading ability, your skills, your ability to convert new K to mental structures, your ability to abstract underlying principles. Differences that **don't matter**: learning preferences aka 'learning styles'. **Intelligence matters** -categories: 1. two types (currently) = fluid (reasoning, abstract thinking, see relationships) + crystallized (K accumulated + mental models). 2. Gardener's multiple intelligences – no empirical evidence, but does suggest more tools. 3. Sternberg's three: analytical (problem-solving tasks), creative (synthesize/apply to new situations), practical (adapt to everyday situation aka street smarts), supported by empirical evidence, static testing does not indicate potential, better= dynamic testing: assess current competence, address weaknesses, re-test. **Structure building does matter**: = extracting salient features of new material + building mental model/ adding to existing model or PK + knowing what to ignore + seeing if it adds nuance/capacity/meaning. **Rule/example learning matters**: rule → extract underlying principles/can apply principles to new material, example → remember many examples / generalize or fit to nearest example, move to rule by making comparisons = powerful.	•
7: Increase your Abilities: Marshmallow test – delayed gratification = later success (result of genes AND motivation). IQs have risen. **Neuroscience**: knowledge/memory/cognition are physiological, gray matter = bodies of nerve cells/white matter = axons + myelin insulation = connections, neurons fire/impulses via synapses, learning happens after synapse formation stabilizes, #synapses peaks aged 2→pruned in adolescence, gross structure determined by genes/fine structure by environment. **Neuroplasticity**: Repeated use→recorded deeper in brain → makes a 'macro' → habit → no conscious effort needed. **Neurogenesis**: learning/ memory makes new neurons in hippocampus. **Increasing IQ**: IQ = genes + environment, has increased, factors: **1.** increased stimulation → curiosity → learning **2.** socioeconomic → stimulation + resources + nurturing → learning **3.** nutrition (some evidence for supplements of fatty acids, iron, B vitamins) **4.** early education → but not a narrow window **5.** cognitive training → evidence of effect of reading etc. if low-income. Brain training: limited if any evidence for effect on fluid intelligence, hard to remove link to self-efficacy. 3 **cognitive multipliers**: **1.** growth mindset (learning goals better aim than performance, persevere when hard), **2.** practicing like an expert (i.e. LOTS of deliberate practice so you know more), **3.** constructing memory cues (mnemonics/memory palace, use *after* mastery, spot patterns).	•
8: Make It Stick: **Tips for students**: **1.** Practice retrieving (self-quizzing/pause when reading to check/check answers/embrace errors/effort = good, easy = bad). **2.** Space out your practice (leave gaps to allow for forgetting/when you're uncertain = time to practice/reloading strengthens memories). **3.** Inter-leave different problem types (mix up the types/compare & contrast/look for patterns/ structure building/being able to discriminate = you'll be better in unfamiliar situations = transfer). **4.** Elaboration (link to PK, find analogies/metaphors/make summaries) **5.** Generation (try to answer question before being taught material) **5**. Reflection (= RP + elaboration to enhance meaning making e.g. learning paragraph – what did I learn). **6.** Calibration (use objective instrument to check your K + U/fluency ≠ mastery). **7.** Mnemonics (NOT tools for learning, memory devices useful after mastery, adds structure). **Tips for teachers**: **1.** Teach them how learning works **2.** Teach them how to study **3.** Create Desirable Difficulties **4.** Be transparent (show them how you incorporate strategies into your teaching e.g. introducing difficulties, RP, SP). **Other strategies**: encourage them to test each other, 'brain dumps' (write everything you know), summary sheets, reflection paragraphs, use Bloom's taxonomy explicitly, make quizzing an integral part of lessons (not linked to grades!), make exams cumulative. **Tips for Trainers**: Often *no* application of these principles, *could* incorporate testing/generation/difficulties/use exercises that get more difficult/use RP.	•