3 research-informed strategies that have been game-changers in my classroom

A little bit about how I got here…

- Taught in the UK
- ResearchED Rugby, and consequences
- Teaching in the US

For each strategy I will talk about

- What the idea is
- What the research says
- The strategies I use, and the impact I have seen

What are the three ideas?

- The Big Picture – the brain, the landscape
- Breaking It Down - explicit instruction
- Building It Up - retrieval practice/spaced practice

research ED
Denver, Colorado

1. The Big Picture – the idea?

The Brain

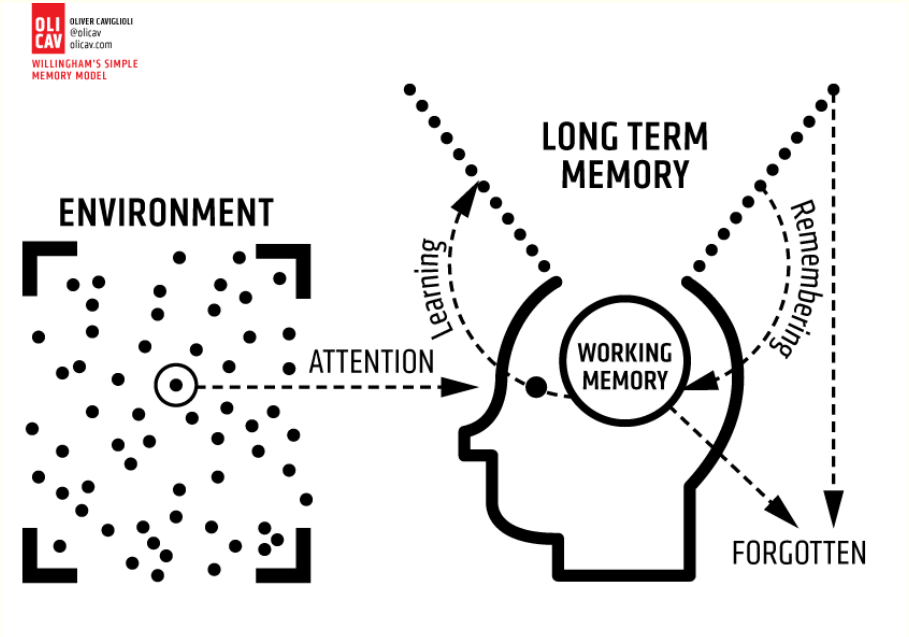
- Cognitive architecture/schema building – working memory/long term memory… making meaning

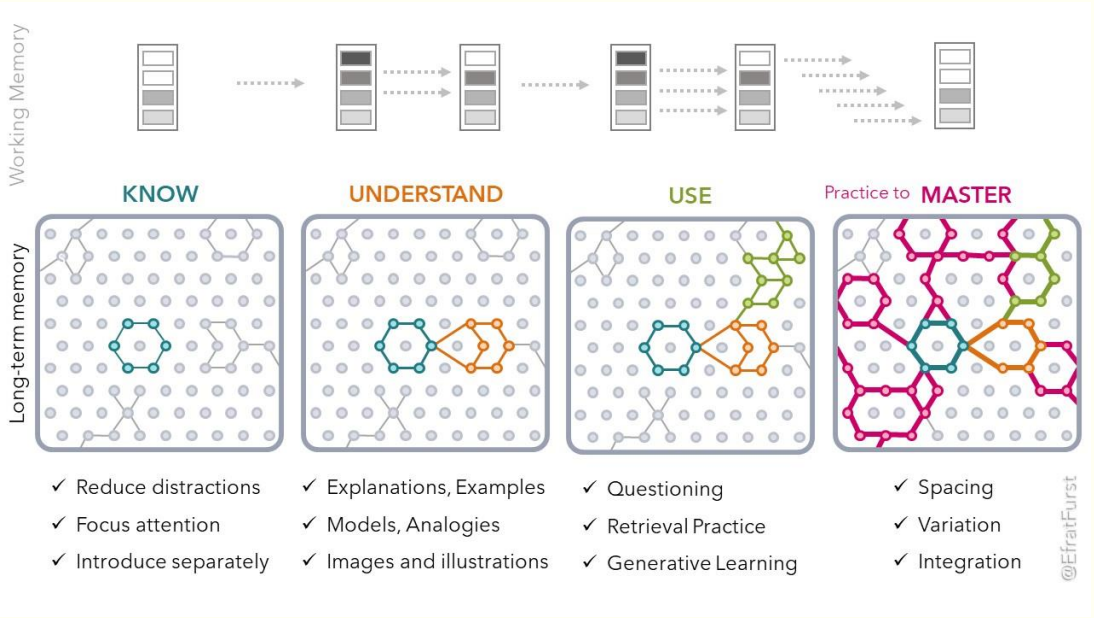
The Landscape

- Advance organizers … knowing where you are going

1. The Big Picture –the research

- (Daniel Willingham's memory model Efrat Furst's schema diagram)



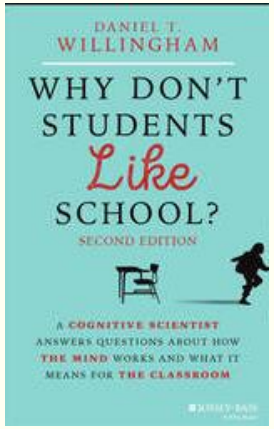


- Ausubel (1960) – using advance organizers
- Chi (1978) – categorizing problems in physics

1. The Big Picture –the research

- Ausubel, D. P. (1960). *The use of advance organizers in the learning and retention of meaningful verbal material.* Journal of Educational Psychology, 51(5), 267-272.
- Chi, M. T. H. (1978). Categorization and representation of physics problems by experts and novices. Cognitive Science, 5(2), 121-152
- Efrat Furst: https://sites.google.com/view/efratfurst/home
- Daniel Willingham: http://www.danielwillingham.com/articles.html

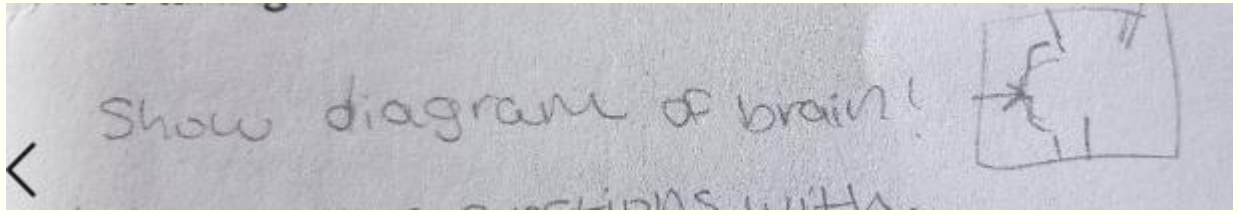
Books:

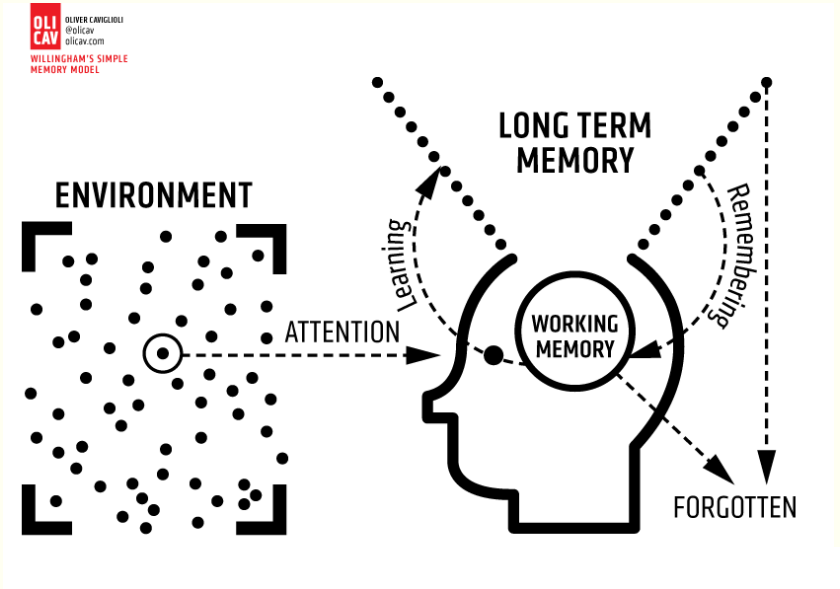


research ED
Denver, Colorado

1. The Big Picture – the strategy

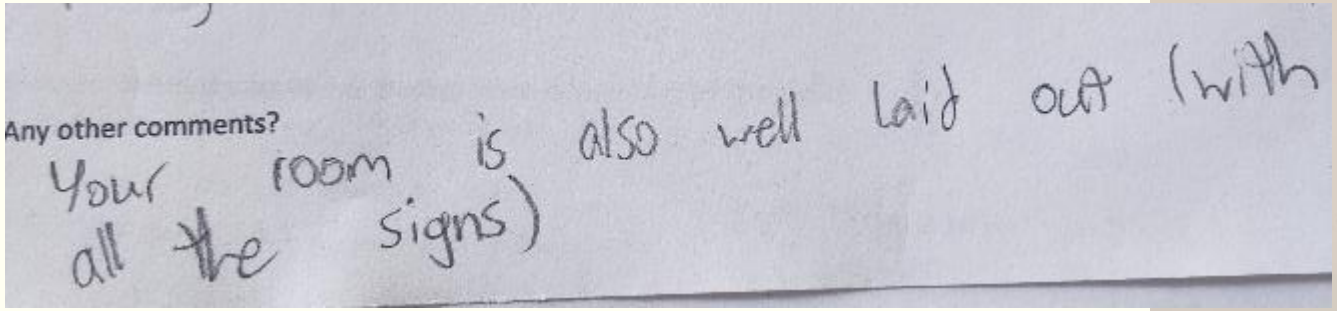
- Explain how learning and memory work





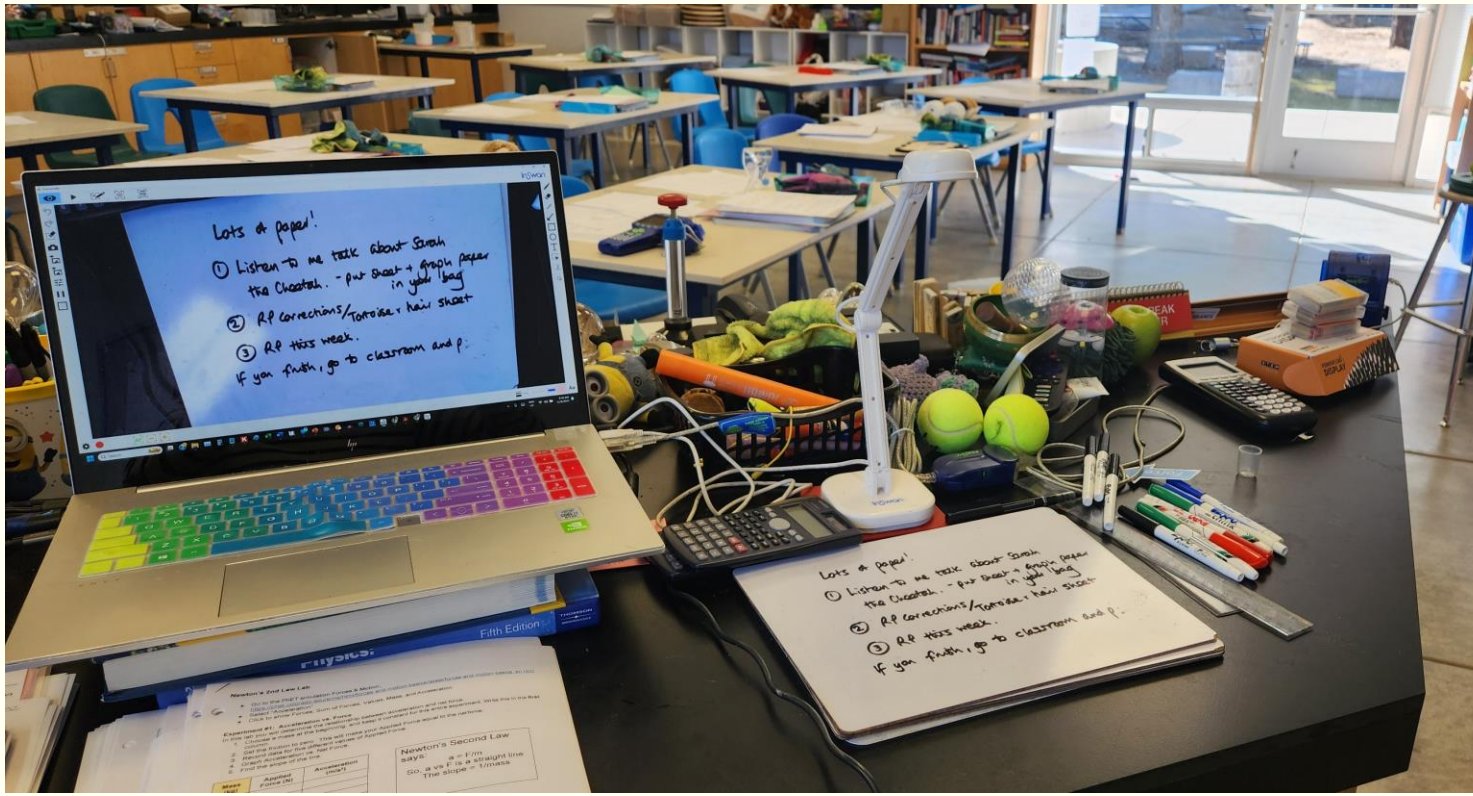
research ED
Denver, Colorado

1. The Big Picture – the strategy



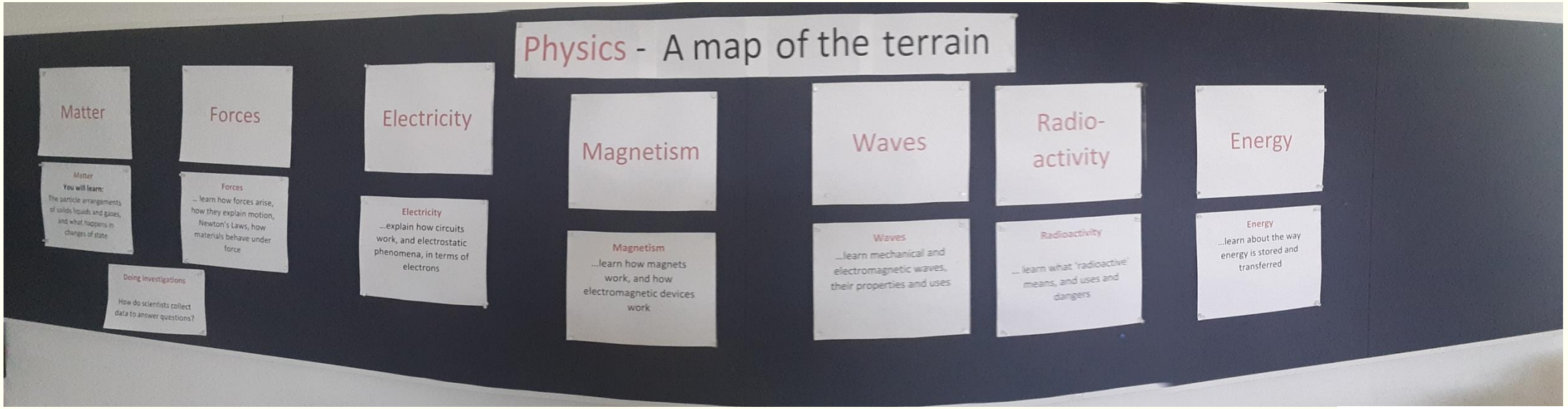
1. The Big Picture – the strategy

- Make my thinking explicit using a document camera
- (and it helps their working memory)



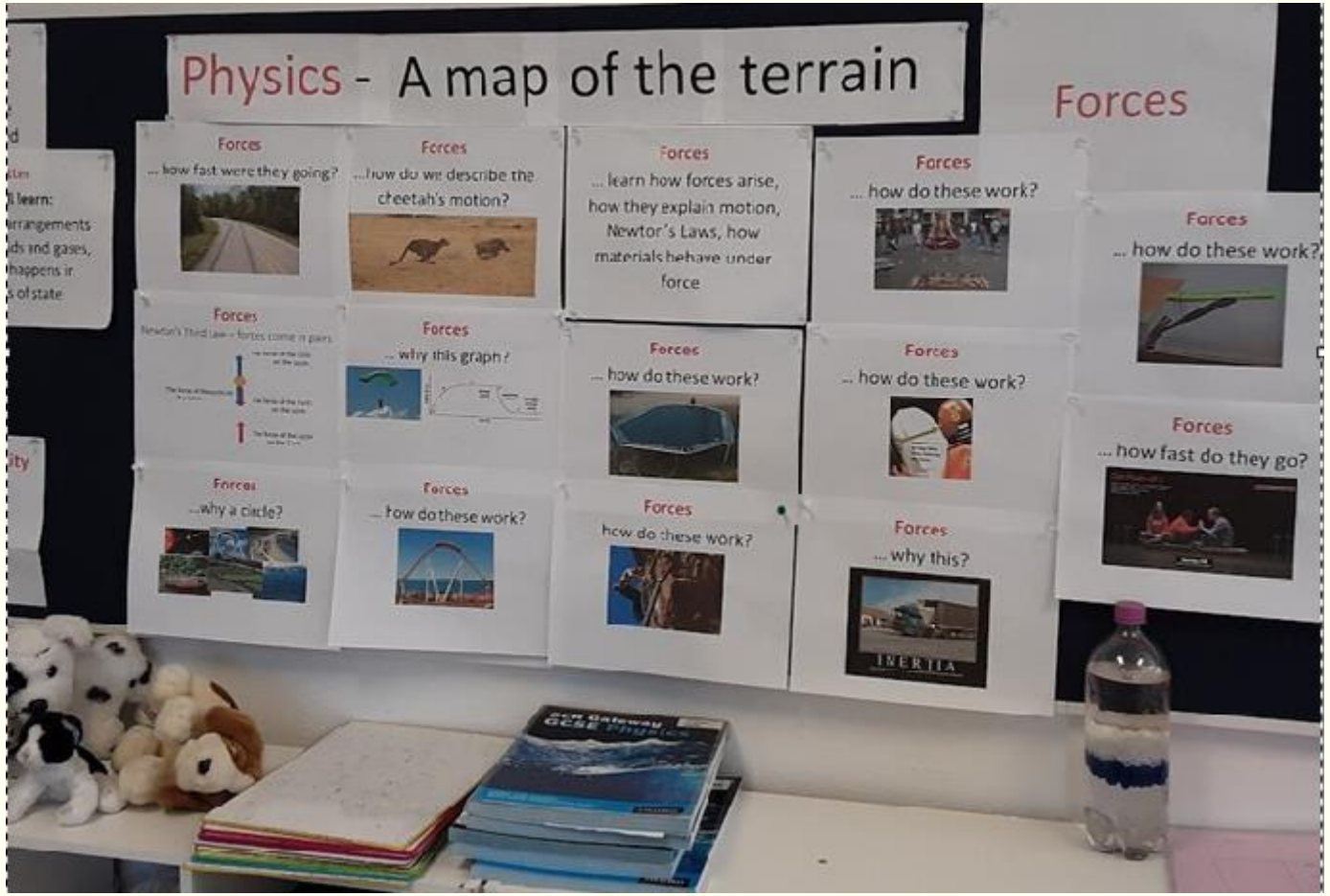
1. The Big Picture – the strategy

- Refer to 'See it like I see it' as the point of the whole exercise



research ED
Denver, Colorado

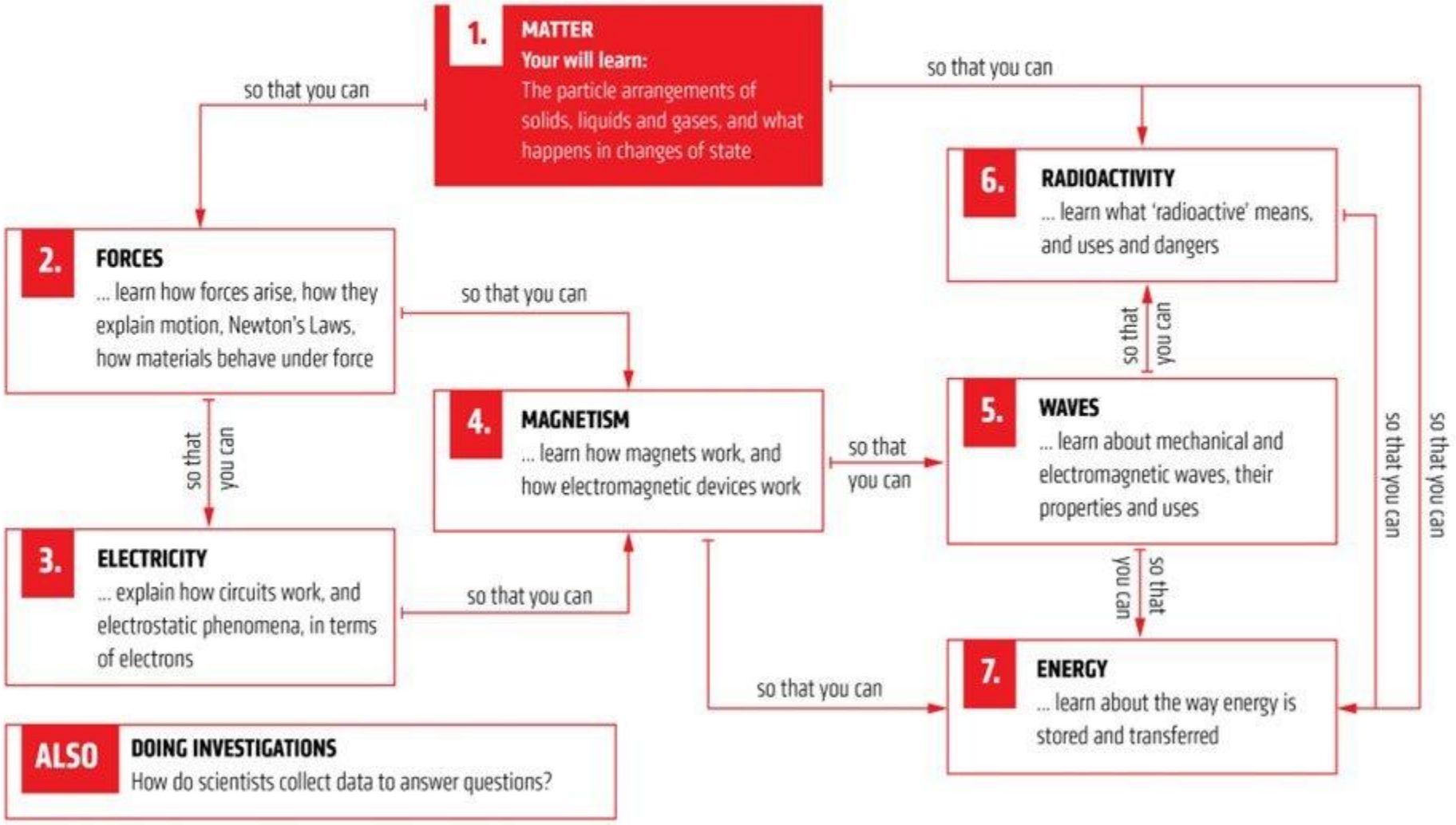
1. The Big Picture – the strategy



MAP OF PHYSICS

Why are we learning this?

Physics is concerned with explaining and predicting the phenomena that we see or can detect, or make happen.
The areas of study are interconnected as shown below.



research ED
Denver, Colorado

1. The Big Picture strategies summarized

Brains and maps of the terrain:

- Teach them about learning, memory and meaning making
- Show them where they are going with an organizer
- Make thinking explicit by talking through it in real time

2. Breaking It Down– the idea

- Explicit instruction, or ‘Just tell them’*… why it’s a good idea
- … while keeping it interactive… not just lecturing
- … and building in formative assessment

* Thanks to Zach Groshell for this phrase

research ED
Denver, Colorado

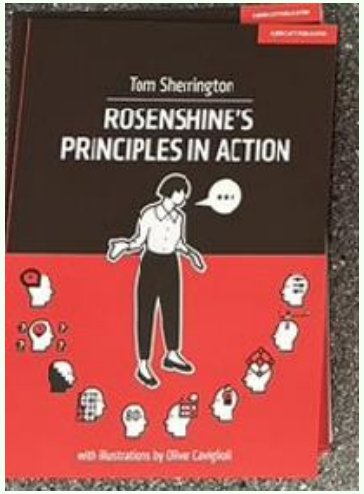
2. Breaking It Down–the research

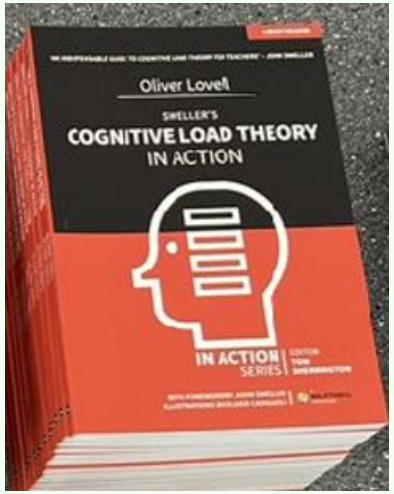
- Rosenshine (2010) – explicit instruction = establish what they know, and need to know, break it down, check they've learned it
- Sweller (1988) - cognitive load theory = maximize their use of WM so they can put it in their LTM

2. Breaking It Down –the research

- Rosenshine, B. (2010). *Principles of instruction: Research-based strategies that all teachers should know.* American Educator, 36(1), 12-19.
- Sweller, J. (1988). *Cognitive load during problem solving: Effects on learning.* Cognitive Science, 12(2), 257-285.

Books:





research ED
Denver, Colorado

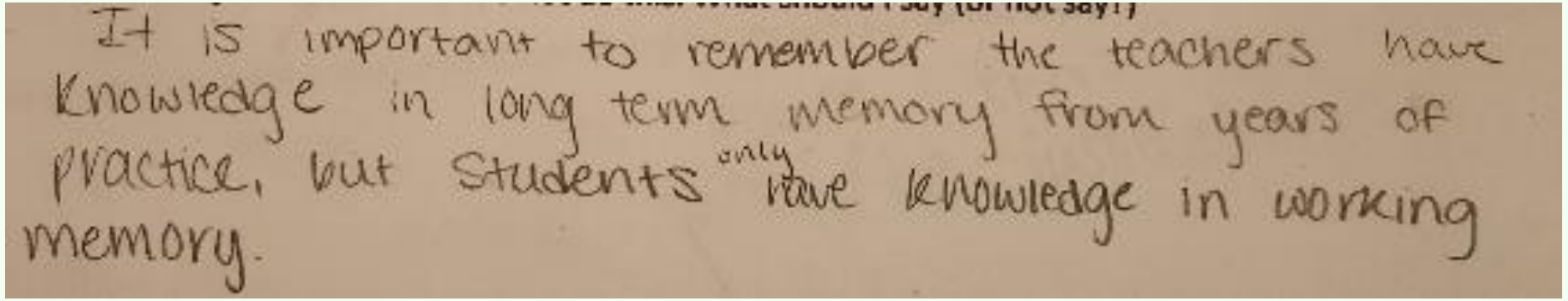
2. Breaking It Down – the strategy

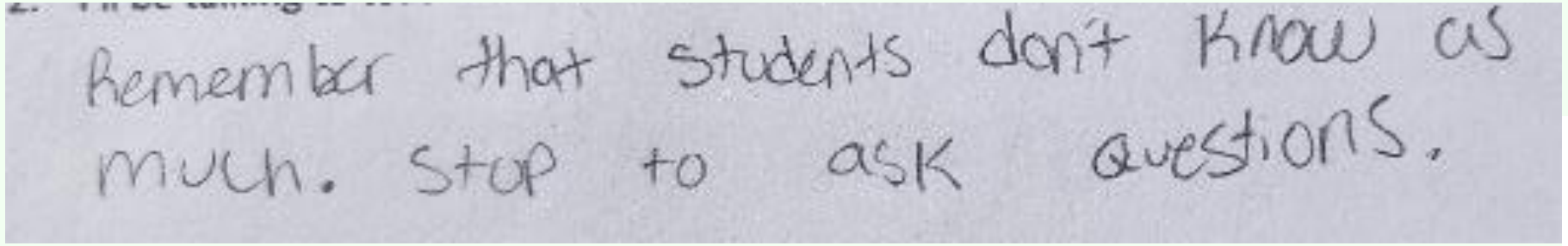
- Review – whiteboards, what do they know/brain dump
- Small steps – chunks depending on where they are (+ doc camera)
- Guided practice – I do/we do/you do, what does good look like
- Check for understanding – whiteboards, turn/talk feedback
- Independent practice – SLOP! (Shed loads of practice)

and

- Remember working memory limitations (cognitive load)
- Remember novices are not little experts

2. Breaking It Down – the strategy



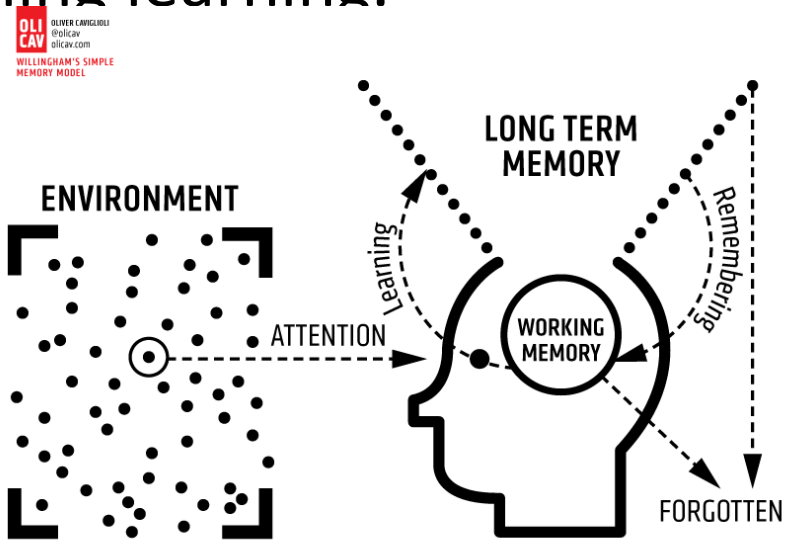


research ED
Denver, Colorado

2. Breaking It Down - strategies summarized

Explicit Instruction:

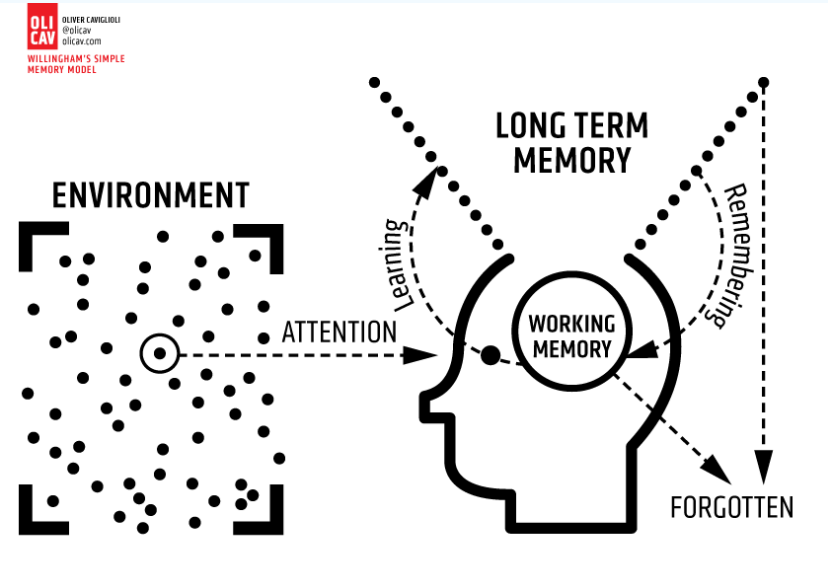
- Chunk it, use document camera to talk it through
- Try to max out their use of WM by removing distractions
- Use mini-whiteboards A LOT for ascertaining learning.



3. Building It Up – the idea

- Retrieval practice… pulling it out of your memory helps you learn
- Spaced practice… leave gaps so there is…

… forgetting



research ED
Denver, Colorado

3. Building It Up – the research

- Ebbinghaus (1885!)
- Roediger, H.L., III, & Karpicke, J.D. (2006) - the testing effect
- Adesope O, Trevisan, D & Sundararajan, N, (2017) – looked at 118 studies

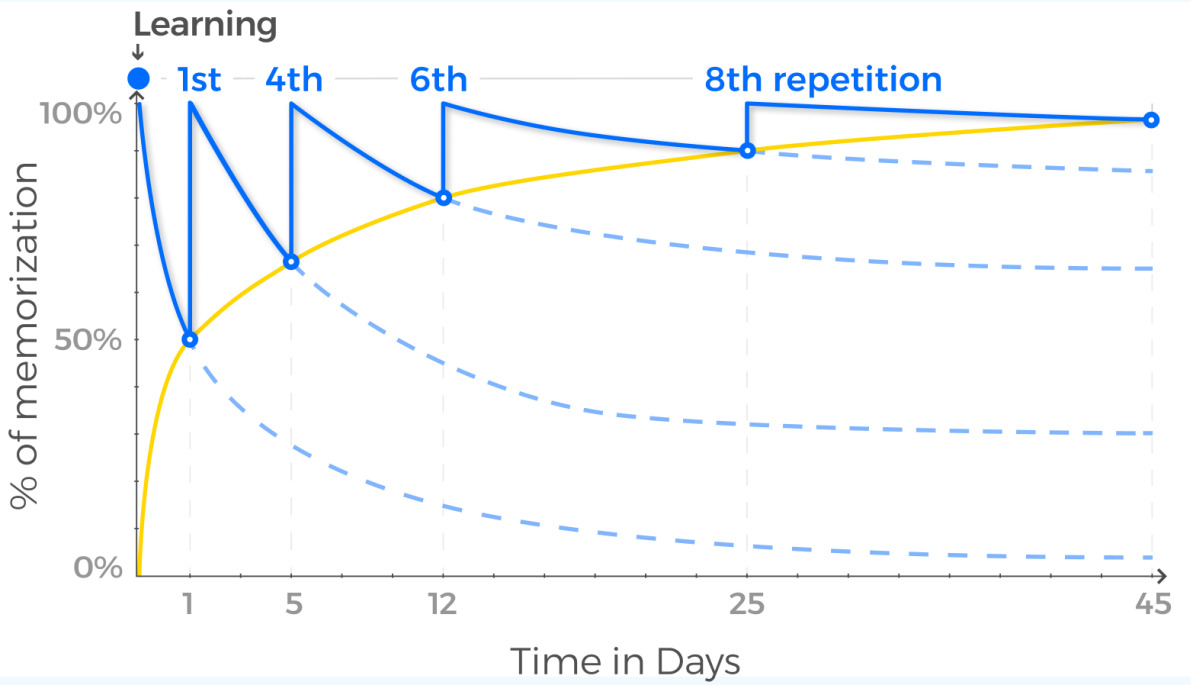
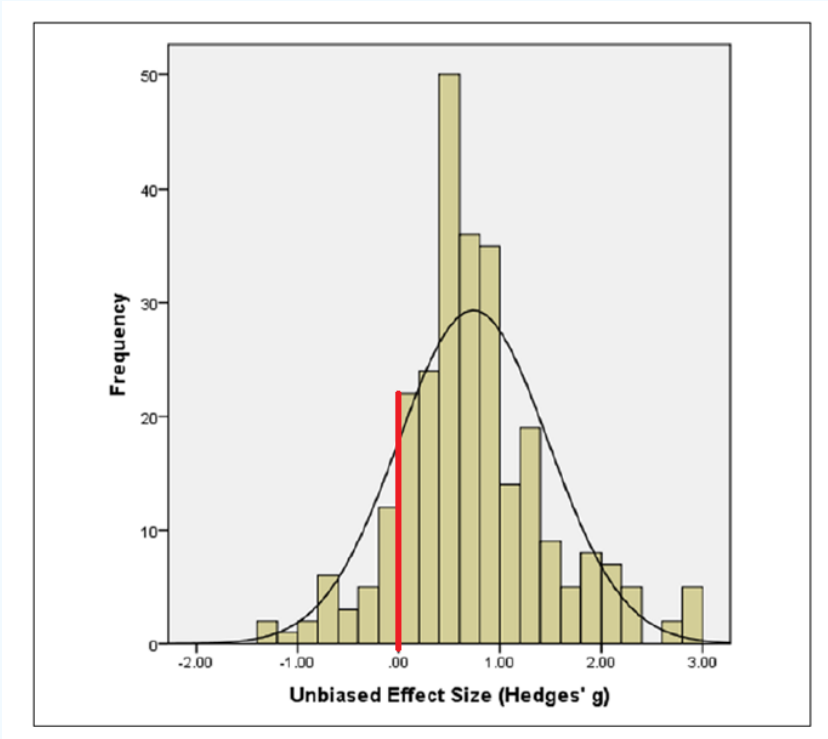


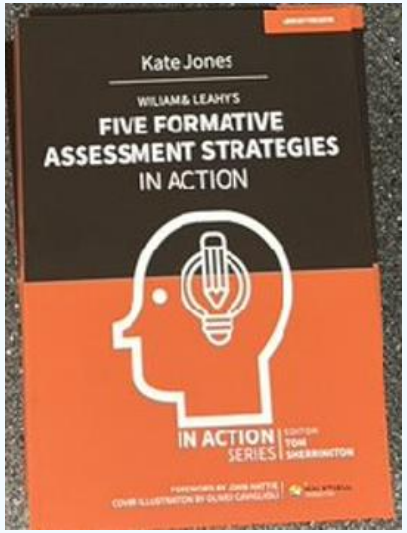
Image: https://www.taalhammer.com/the-forgetting-curve-hermann-ebbinghaus/

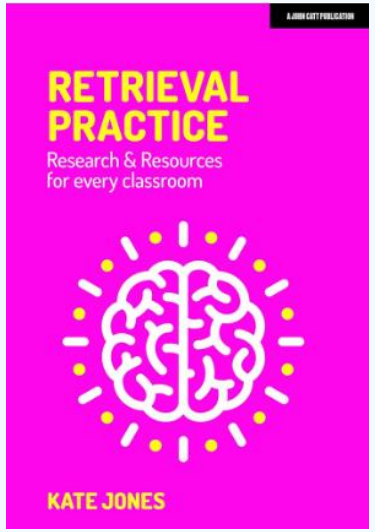


3. Building It Up – the research

- Ebbinghaus, H. (1885). On memory: Investigations into experimental psychology. *Psychologische Forschung, 2*, 123-144.
- Roediger, H.L., III, & Karpicke, J.D. (2006). Test enhanced learning: Taking memory tests improves long-term retention. *Psychological Science,* 17, 249–255.
- Adesope O, Trevisan, D & Sundararajan, N, (2017) Rethinking the Use of Tests: A Meta-Analysis of Practice Testing, *Review of Educational Research*

Books:





researchED Denver, Colorado

- repetition is the most valuable strategy

SLOP- Active recall

•Talk about the necessity of SLOPS

• 3x to get into long term memory

SLOP

SLOP

the whole idea of SLOP

-Emphasize different kinds of retrieval practice, most other teachers don't do it

Retreival practice - always revisiting topics to keep t on the brain

SLOP.

SLOP converts what you lear term to long term memory

Repetition!!!!

3. Building It Up – the strategy

- Retrieval practice = weekly review quizzes
- Low stakes – ALL can be corrected for 100%
- Questions that:
  - are spaced: last lesson, last week, a long time ago
  - get progressively harder/more abstract/connecting topics…

3. Building it up strategies summarized

Retrieval/Spaced Practice:

- Regular short quizzes about everything important (retrieval practice)
- Ask about things from a while ago
- Let them correct everything/make it LOW stakes

Takeaways

- Be explicit about
  - What you are thinking
  - What you are doing
  - Why you are doing it

Useful lenses

- To ‘see it like I see it’ is why we are here
- Novices are not little experts; they learn differently.
- Working memory is limited; load it wisely
- Learning involves a change to a learner’s long-term memory
- Having a model of memory and learning (Willingham) is extremely helpful if you are trying to learn anything as it helps you choose strategies that are likely to work well.

FIGURE 1:
EVIDENCE-INFORMED PRACTICE

https://my.chartered.college/impact_article/addressing-the-challenges-of-using-evidence-in-education/


Edited by John Tomsett
COLLINS ET AL.'S
COGNITIVE APPRENTICESHIP IN ACTION
IN ACTION SERIES
Sonia Thompson
BERGER'S
AN ETHIC OF EXCELLENCE IN ACTION
IN ACTION SERIES
Sarah Cottingham
AUSUBEL'S
MEANINGFUL LEARNING IN ACTION
IN ACTION SERIES
Oliver Lovell
SWELLER'S
COGNITIVE LOAD THEORY IN ACTION
IN ACTION SERIES
Emma Turner, David Goodwin & Oliver Caviglioli
ANNIE MURPHY PAUL'S
THE EXTENDED MIND IN ACTION
IN ACTION SERIES
Amarbeer Singh Gill
DUNLOSKY'S
STRENGTHENING THE STUDENT TOOLBOX IN ACTION
IN ACTION SERIES
Tom Sherrington
ROSENSHINE'S PRINCIPLES IN ACTION
with illustrations by Oliver Caviglioli
Kate Jones
WILIAM& LEAHY'S
FIVE FORMATIVE ASSESSMENT STRATEGIES IN ACTION
IN ACTION SERIES
Zoe & Mark Enser
FIORELLA & MAYER'S
GENERATIVE LEARNING IN ACTION
IN ACTION SERIES
Jade Pearce & Isaac Moore
BJORK & BJORK'S
DESIRABLE DIFFICULTIES IN ACTION
IN ACTION SERIES

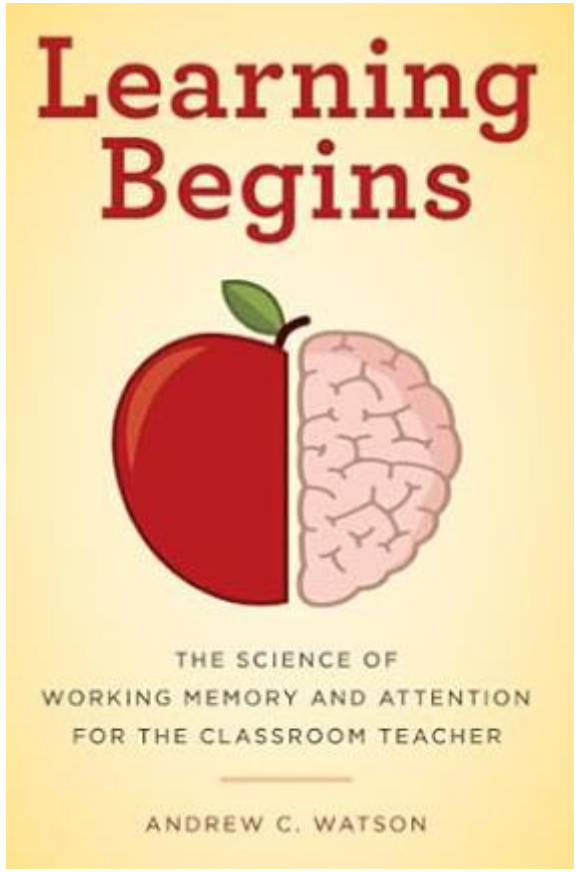
Another great book…

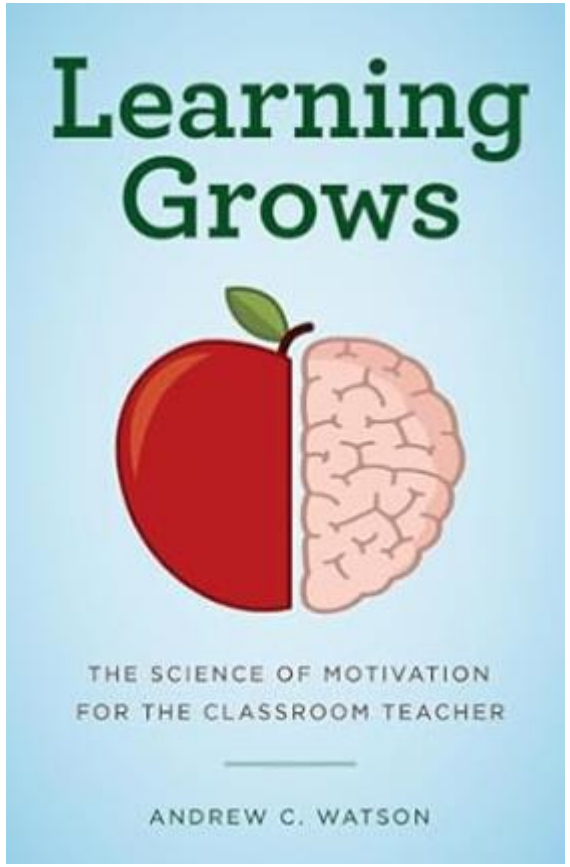
How Learning Happens 2nd Ed (by Paul A. Kirschner and Carl Hendrick) – Planning Summary

		What	What to know and what to do	… and not do
Memory and cognition		1. Working memory	Working memory (WM) is limited, and more like 4 than 7 can be recalled – don't overload BUT struggle can be good. . Chunking REALLY helps. Use (unlimited) long term memory (LTM).	Don't overload WM AND (the challenge)… Don't make it too simple
		2. Opening the black box	Working memory is dynamic and we have at least 5 WM stores. Cognitive overload negatively affects performance – avoid by chunking/organization.	Don't distract with seductive details (e.g. photos of cats).
		3. Ah yes, I remember it well	Episodic memory (EM) storage (your 21st birthday) can change, semantic memory (SM) storage (e.g. times tables) not so much. Get THEM to link to episodic with semantic for a stronger memory/use dual coding/make meaning to capitalize on EM.	Don't use gimmicks (Swiss rolls in maths) - they will remember the event, not the content.
		4. "What you know, you know"	Everyone has a bunch of schemas (ways info is organised). New information is evaluated against them, schemas adapt. Talk about 'remembering' not 'memories'.	Don't assume they will remember *exactly* - no one does.
		5. Do you know what you know? Metacognition	Metacognition (thinking about thinking) is not fairy dust – you can teach it; you can get better at it. We can model it: planning/ strategy choice, monitoring, evaluation.	Don't teach it as a 'generic' skill – link to domain knowledge.
How does our brain work?		6. A novice is NOT a little expert	Children are NOT small adults. They see the world differently. Things that work for experts DON'T work for novices and vice versa, so don't mix them up. Beware the curse of knowledge.	Don't ask them to do things only experts do.
		7. Take a (cognitive) load off me	You don't learn piano using Rach 2 - break it down. Solving a problem is NOT the same as learning how to solve a problem. Teach steps separately. Heed human cognitive architecture.	Don't teach a complex system using complex systems.
		8. Dancing in the dark	Skilled = turning declarative into procedural knowledge Novices use weak strategies (e.g. trial and error/means-ends), need help to move to expert problem solving (backwards from solution).	Don't engage in applications/problem-solving too soon.
		9. An evolutionary view of learning	We easily learn things we need for survival (bio primary) BUT reading, writing, science… (bio secondary) need effort (tell them!) Help Ss manage interests, use bio primary to motivate (carefully).	Don't use too many gimmicks/novelties to appeal to bio primary.
		10. One picture and a thousand words	There are two cooperating memory systems: verbal/non-verbal. Most efficient to use both so e.g. integrate text into diagrams or talk around your diagrams. Use LOTS of examples for abstract concepts.	Don't use unnecessary images/read PowerPoint slides.
Prerequisites for learning		11. What you know determines what you learn	Prior knowledge is key - be clear about what is needed, reteach it if necessary, give them a framework to work from Go from general concepts to specific – do comparisons old to new.	Don't assume they know it, don't use what *you* know as the start point.
		12. Independent learners	Independent learning is NOT a good way for a novice to become an independent learner. Make sure they have requisite domain knowledge. Modelling/talking helps them learn self-regulation.	Don't say 'do your best', don't set novices independent tasks.
		13. Beliefs about intelligence can affect intelligence	'Entity' theory of intelligence = fixed, related to performance goals. 'Incremental' theory = changeable, learning/ mastery goals – set up mastery through challenges, talk about effort producing gains.	Don't use 'smart' to refer to Ss, don't go on about grades.
		14. … thinking makes it so	Self-efficacy (belief in one's ability to do a task) is key – is boosted by early success, so give them that; success begets motivation. Teacher modelling helps alleviate anxiety. Talk about that.	Don't use nebulous language or encourage mutual competition.
		15. Perception of achievement is the key	What you attribute your achievement to is more important than achievement. Your perceived locus, stability, controllability is as significant as actual. Point out things THEY control.	Don't attribute success to things outside their control/praise too much.
		16. Where are we going and how do we get there?	Students can be mastery oriented or performance oriented, both can work, and happen at the same time. Fear of failure inhibits both Show Ss that mistakes are OK.	Don't use performance to assess mastery (or tell them they're the same).
Which learning		17. Why scaffolding is not as easy as it looks…	… because it's about how the problem appears to them, not you. Help them see the difference by talking out loud. Help them build low level skills + increase difficulty, reduce scaffolding.	Don't think they see it like you see it.
		18. The holy grail	1:1 tutoring is 2-sigma better than classes for average students. Can't tutor but can: use advance/knowledge organizers (KOs) at the start, summaries at the end. With mastery learning all can achieve.	Don't use 'hands-up'. Don't give out KOs at the end.
		19. Problem solving	Students' internal conceptualizations of a problem (problem space) is different to ours. Teach how to selectively search problem space, break it down, know where to start. Practice (with variety) is GOOD.	Don't call it 'Drill and Kill'. Don't keep *your* mental models secret.
The teacher		20. Activities that give birth to learning…	… are mathemagenic, will 'make the horse drink'. Learning involves object orientation, selection, translation, processing INSIDE the learner – we have to get conditions right so they DO something inside	Don't assume they will 'drink' because you led them there.
		21. Zoom out to zoom in	Elaboration theory say students need contextual understanding of the domain. Start lesson sequence with 'epitome' of topic/task Sequence: simple-complex, general-detailed, concrete-abstract.	Don't give discrete chunks without big picture, or vice versa.
		22. Why discovery learning is a bad way to discover things	Human cognitive architecture has possibilities AND limitations; LTM is (virtually) infinite, 'discovery' can overload WM. Learning is a change to LTM. Use explicit instruction that takes architecture into account.	Don't use minimally guided instruction with novices.
		23. Direct instruction (Rosenshine, who says…)	…begin with review/new stuff in small (limited) steps/detailed instruction/lots of Qs + check for understanding/ SLOP/think aloud, model steps + worked out solutions/ask them to explain/provide feedback + corrections/move to independent practice.	Don't assume 'learner-centred' is better. Don't conflate DI with lecturing.
		24. Assessment *for* not *of* learning	Research says assessment of progress must inform you and student on what to do next. Formative assessment = 'responsive teaching'. Give back some work with comments only/use rubrics, peers.	Don't just do summative assessment. Don't always grade.
		25. Feed up, feedback, feedforward	Getting them to act on feedback is key. Feedback continuum: corrective (right/wrong)/directive (how to do it; reteach)/epistemic (think about how to do it better); Ss should work harder than you.	Don't say the equivalent of 'be funnier'/praise the student not the work.
		26. Learning techniques that really work	Students don't know how to study well, they forget (Ebbinghaus). High impact: practice testing/distributed practice Med impact: elaborative interrogation/self-explanation/ interleaved practice	Don't assume they know *how* to learn. Don't assume you do!
Learning in context		27. Why context is everything	Students learn from observing others, learning is not context-free. Prior knowledge is a bigger factor to learning than age. Carefully sequenced explicit modelling better than getting them to work it out. Novices need modelling that is *complete*.	Don't ignore social learning (role play, peer teaching). Don't use age as a gauge.
		28. The culture of learning	Cognitive apprenticeship is useful structure – teacher as role model. Contextualise tasks to help integrate knowledge/skills. Practice part-tasks *first*. Discussion can produce shared language of learning.	Don't think you can teach generic skills.
		29. Making things visible	4 dimensions of apprenticeship: content, method, sequence, sociology. Explicitly describe how you navigate the problem space – think aloud. Put tasks in authentic contexts/multiple situations.	Don't assume they know what you are thinking.
		30. It takes a community to save $100 million	Teachers need communities of practice = people coming together. Build one to share domain knowledge, and community (belonging means engagement, imagination, and alignment).	Don't have hard or protected boundaries around your community.
Cautionary tales	VAK	31. Did you hear the one about the kinaesthetic learner… ?	Digital natives and learning styles do NOT exist. Teach how to find reliable and valid information online, and how to navigate the problem space.	Don't ask them how they learn best – they don't know.
		32. Activities that give kill learning…	…are mathemathantic. What works for some can be counter-productive for others (expertise reversal effect) – beginners need much guidance, more experienced learners don't… first do no harm.	Don't assume everything works for everyone – check first.
		33. The medium is NOT the message	It's not the medium but the instructional method that influences achievement. Select the most appropriate medium – less is more Just because they are engaged doesn't mean they are learning.	Don't fall prey to the hypes around (multi)media.
		34. The ten deadly sins	1. The learning pyramid is not correct 2. Learning styles are not correct 3. Young people are not digital natives 4. Children/people can't multitask 5. You can't just Google it	6. You don't learn to solve problems by solving problems 7. Discovery learning is not the best way to learn 8. Motivation does not lead to learning 9. Grit isn't different from perseverance 10. Schools don't kill creativity
Lethal mutations		35. Lethal mutations – AVOID ALL of these:	1. Rosenshine → checklist of must-dos 2. Desirable difficulties → making them fail 3. Retrieval practice → every lesson 4. Constructivism as philosophy → use as pedagogy 5. Biologically primary → instruction isn't needed 6. Dual coding → illustrations for their own sake	7. Interleaving → rotating subjects 8. Cognitive load → striving to minimize load 9. Zone of proximal development → group work 10. Self determination theory → give autonomy 11. Success begets motivation not vice versa 12. Kolb Experiential Learning Theory → learning styles 13. Flipping classrooms → 3 wrongs do/don't make a right.

Made by Helen Reynolds, @helenrey Graphics courtesy of https://thenounproject.com/

Two more great books:





Feel free to contact me!

- @helenrey on X
- helen.reynolds@physics.org

… and thank you very much for listening!