Ways of Learning from Neuroscience & Learning Theories

Or Why Learning Can Make You Happy

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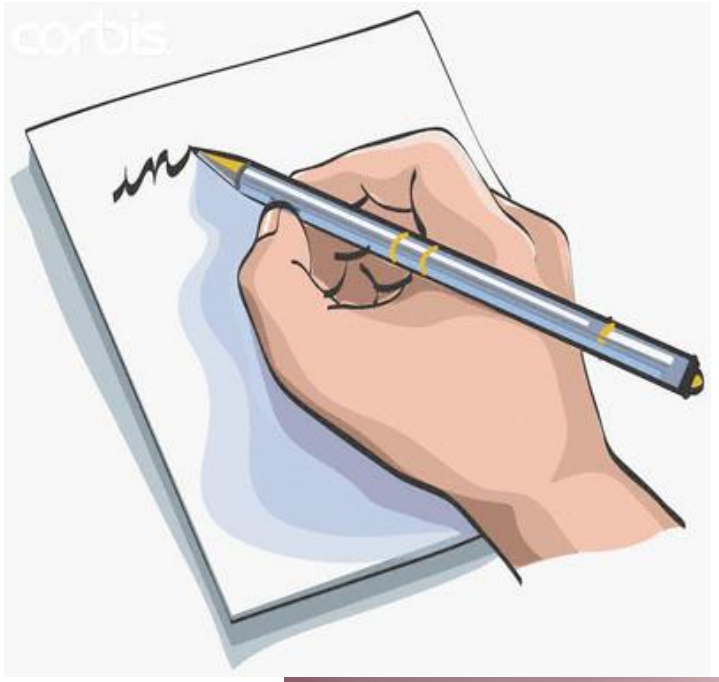
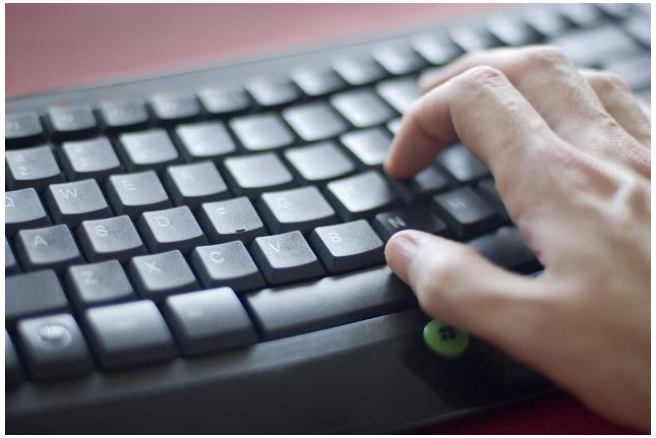
What are your assumptions about learning?





why take notes?

Taking notes is a strong method to retain what you're hearing.

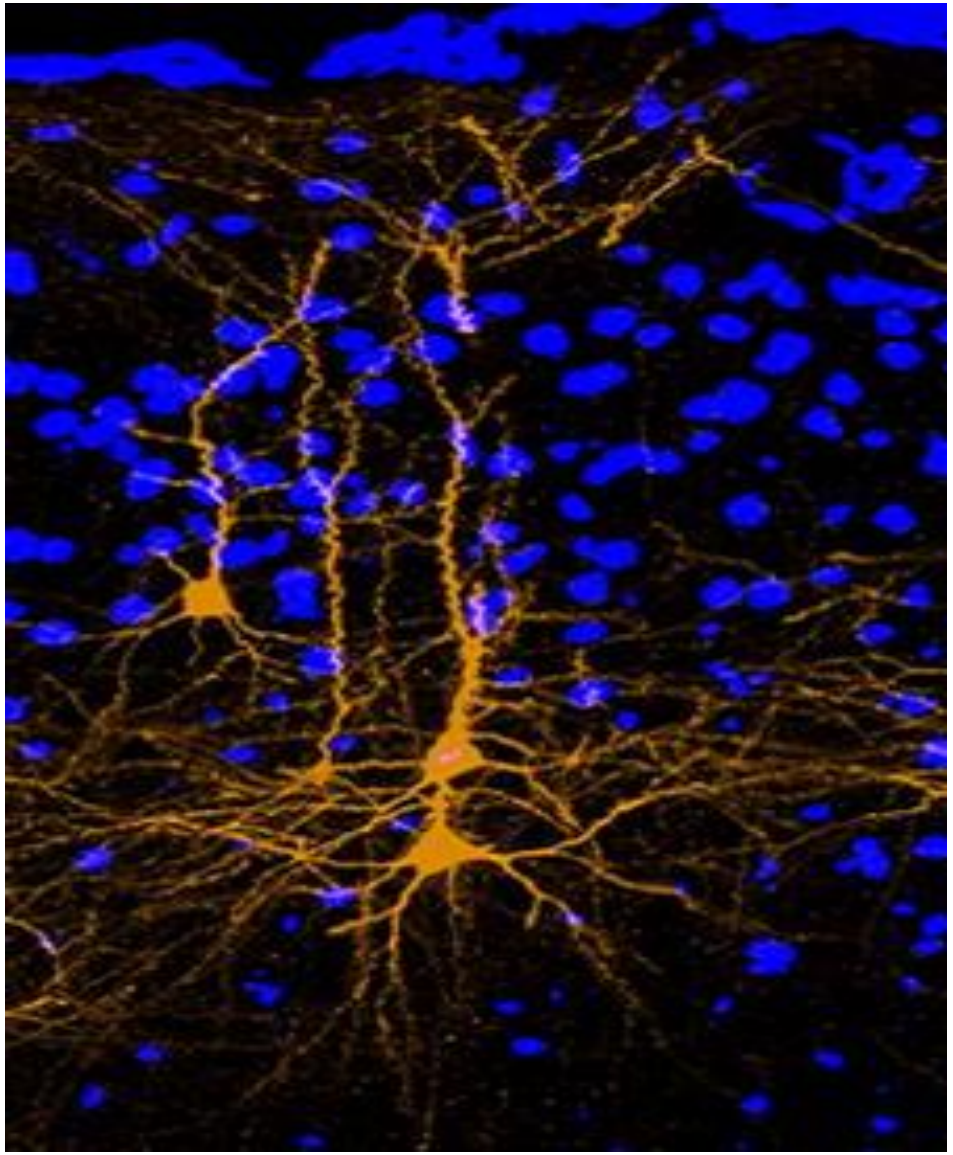
People taking notes by hand **retain better conceptual understanding** than people who typed their notes.

Mueller, P. a, & Oppenheimer, D. M. (2014). The Pen Is Mightier Than the Keyboard: Advantages of Longhand Over Laptop Note Taking. *Psychological Science*, *25*, 1159–1168. https://doi.org/10.1177/0956797614524581

Meta-cognition!

Thinking about Thinking

The act of noticing how you are thinking, what leads to productive work and what leads to a dead end



What's happening inside the brain when we learn?

Image source: http://www.brainfacts.org, Nelson, et al. The Journal of Neuroscience, 2013.

Exercise : a memory

- With a partner discuss a time you learned something
  - Can you recall events, sensation relating to senses other than vision?
  - How long ago was this memory?

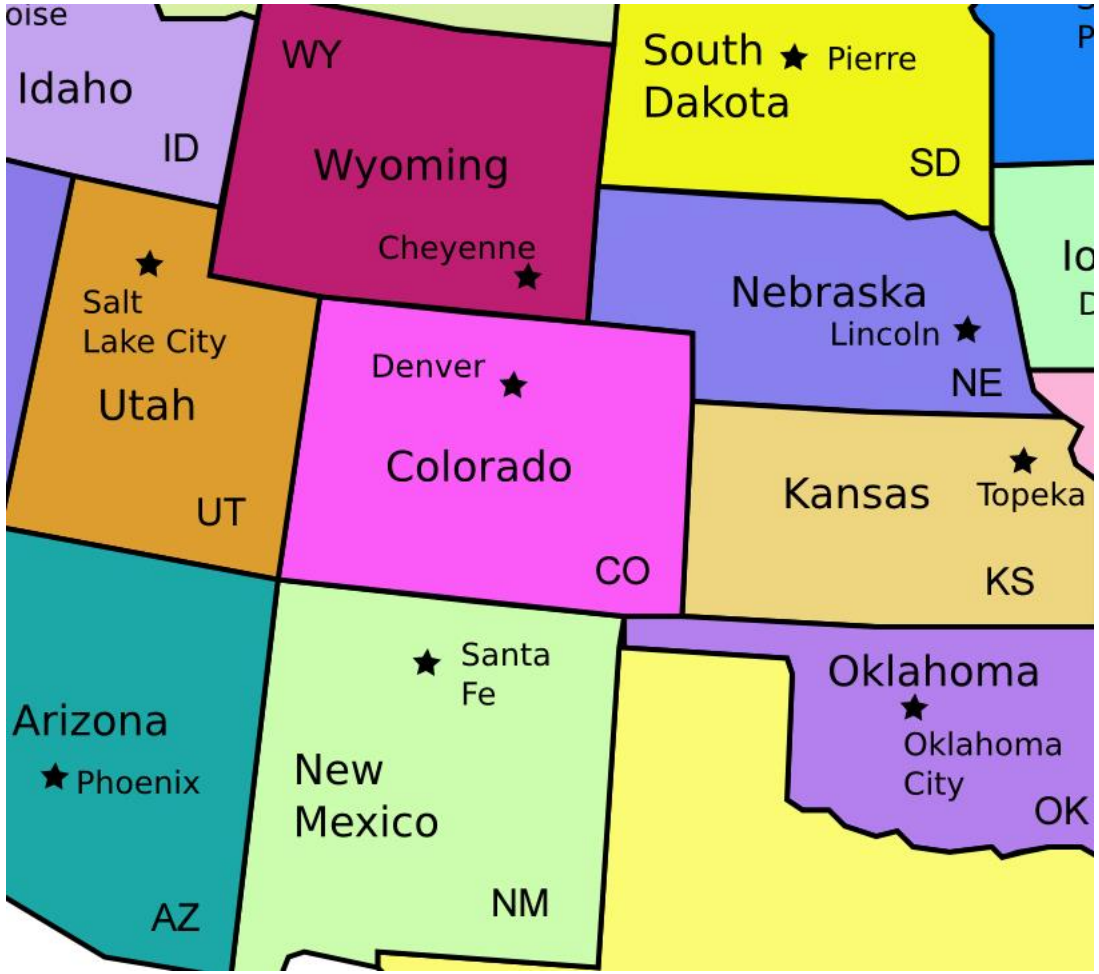
Episodic Memory

Exercise: Remember a fact

- With a partner:
  - List all the states that have a common boundary with Colorado
  - List their capitals

Semantic Memory

For those who really want an answer:



Declarative Memories

- Episodic (I can tell you the episode or story)
- Semantic (I can tell you the fact I know)

“rememberi something”

“learning something”

Exercise: repeat a skill

- List daily tasks you don't have to really think about to do.

Non-declarative or Procedural Memory

Neurons learn in 2 ways

- Error-driven Learning

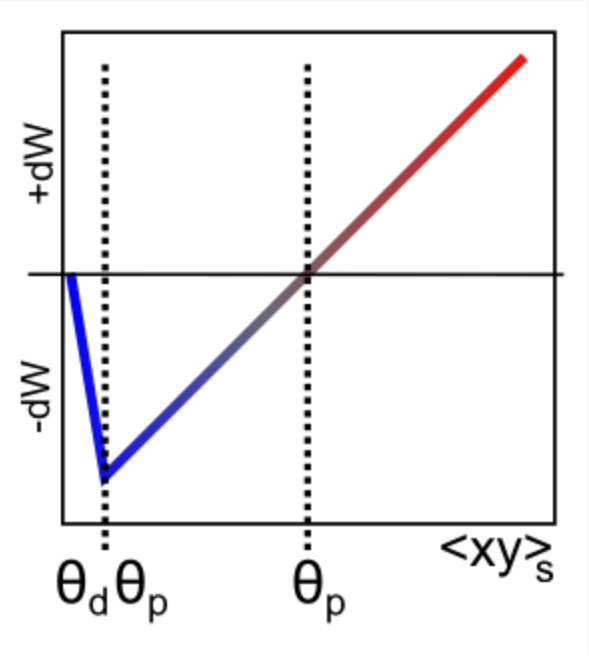
"Well, that didn't go like I expected"

- Hebbian Learning

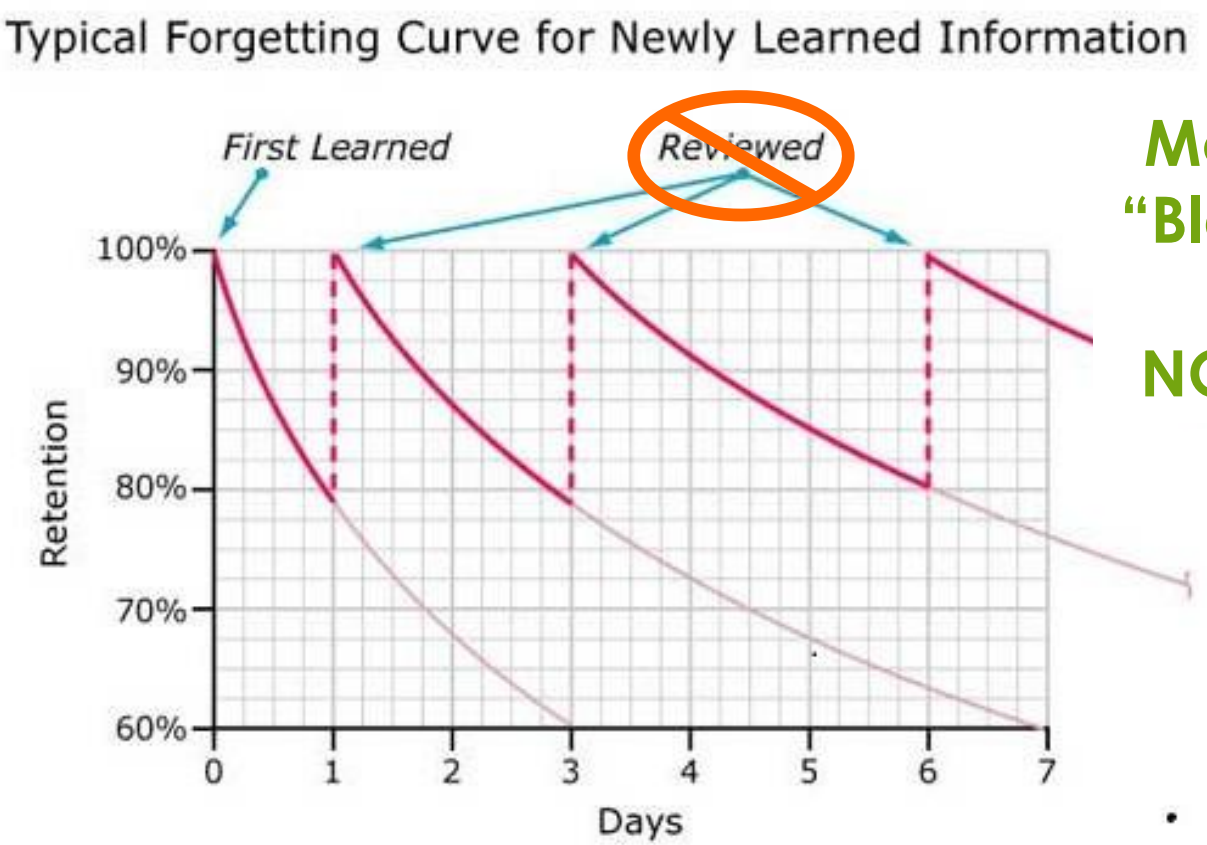
"What fires together wires together"

Error-Driven Learning

- Neurons require a certain amount of neuro-transmitter to fire. That threshold (Θ) is flexible
- When something unexpected happens, it resets to a new level



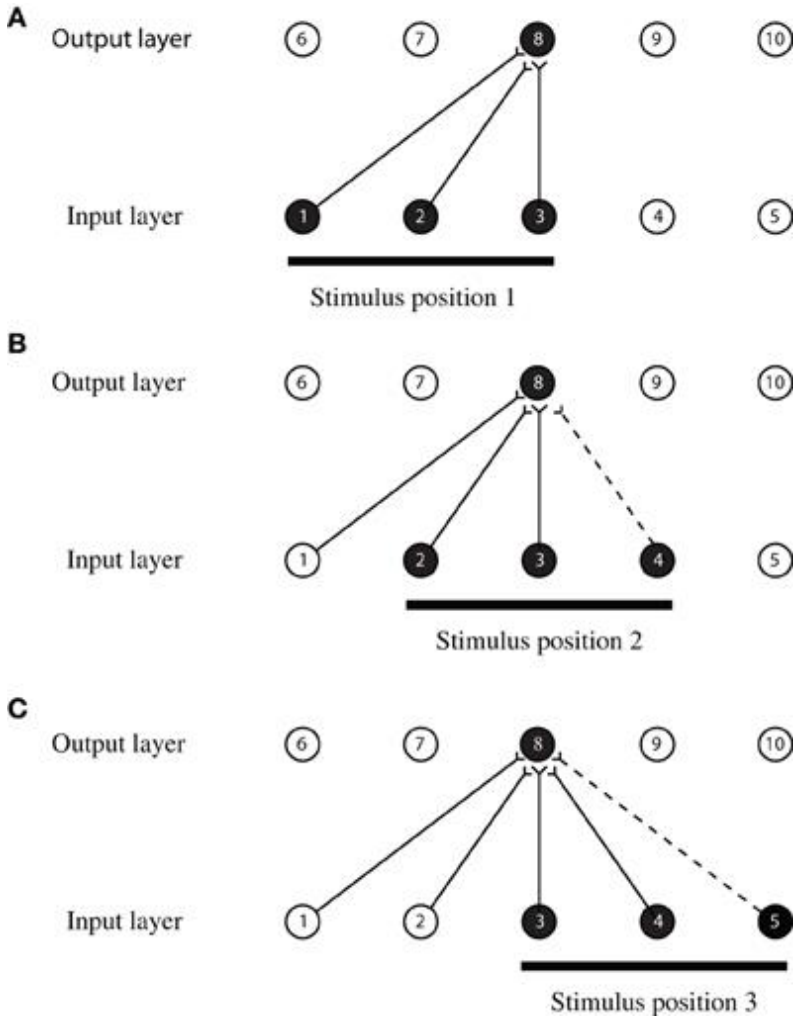
Spaced Recall uses Error-Driven Learning



Moments of "Blank Page" Testing NOT REVIEW

Hebbian Learning

- Sets of neurons fire together
- If one part of a neural sequence fires, the others that often fire with it will weakly activate



Error-Driven

- Learning a new fact can happen in a single instance
- Long-term learning assisted by repeated error-driven moments
- Placed into long term memory from working memory by your hippocampus during sleep

Hebbian

- Skills are learned through repeat exposure
- Method of "remembering" not completely understood

Source: https://grey.colorado.edu/CompCogNeuro/index.php/CCNLab

Long term memory is structural – your neurons are wired in a new configuration

Short term (working) memory is (somewhat) electrical – which is why something can "slip your mind"

Learning Theories

or

what do we think learning is on a whole-person scale?

Two Metaphors for Knowing

Plato

- We draw knowledge up out of ourselves
- Socratic method – guided questioning draws out knowing
- ***Recollection*** from *Meno*

Aristotle

- We settle down into knowing
- We experience things outside ourselves, and by settling into a particular context, learn it.
- Greek ***hexis***, often translated as **habit**

(Aristotle never said)

We are what we repeatedly do. Excellence is not an act, but a habit."

- William Durant

(1926, summing up part of Aristotle's *Ethics*)

Problem: Recall & Habit - too Passive

Plato's *Recollection* is better described as introspection or **reflection**

Piaget's **Constructivism**

Focuses on learners *assimilating* new concepts to regain *equilibrium*

Highlights the need for *reflection*

(Piaget, 1964)

Problem: Recall & Habit - too Passive

Aristotle's *Habit* better described as **immersion**

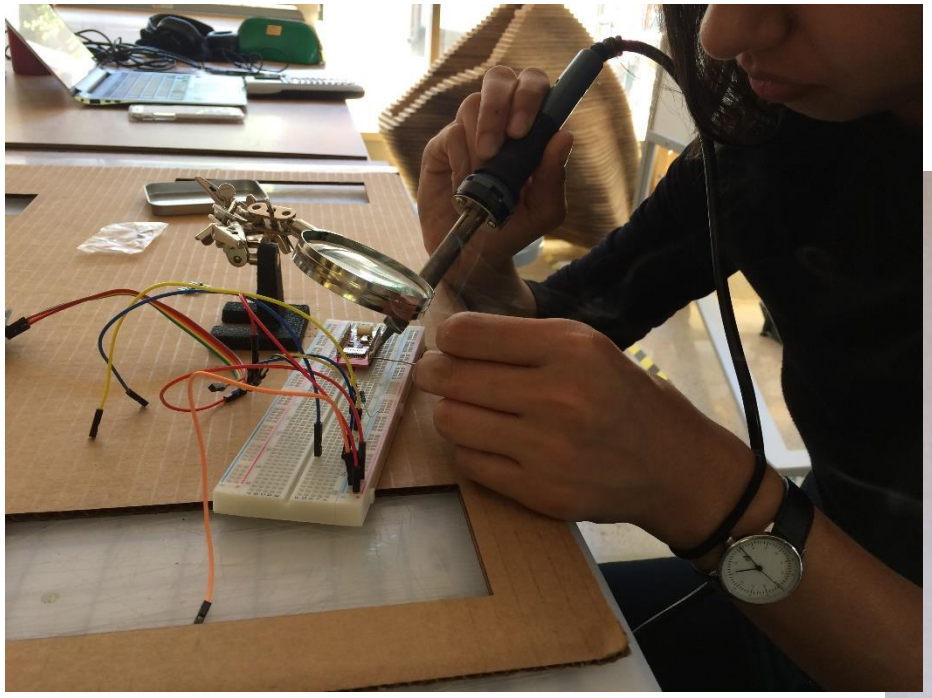
Papert's **Constructionism**

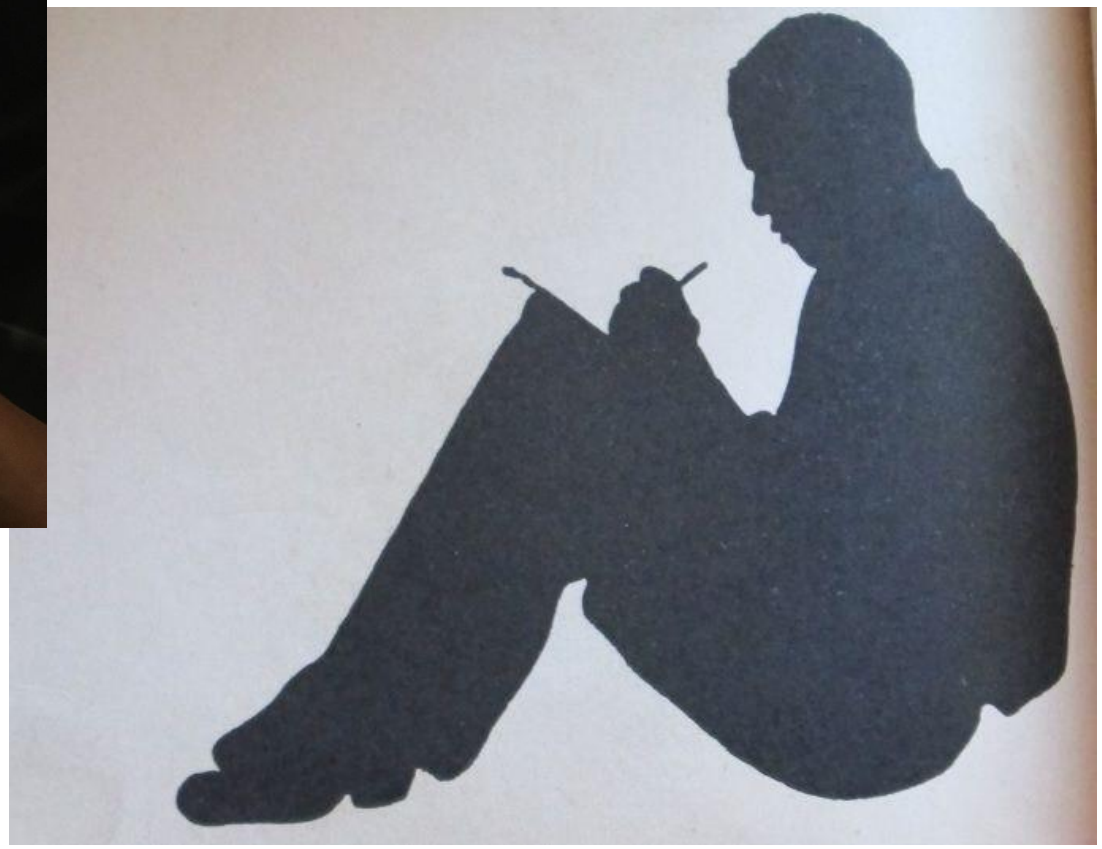
- Focuses on learners need to construct new ideas as structures in their minds; this is most easily accomplished while building things

- Highlights the need for *immersion*

(Papert & Harel, 1991)

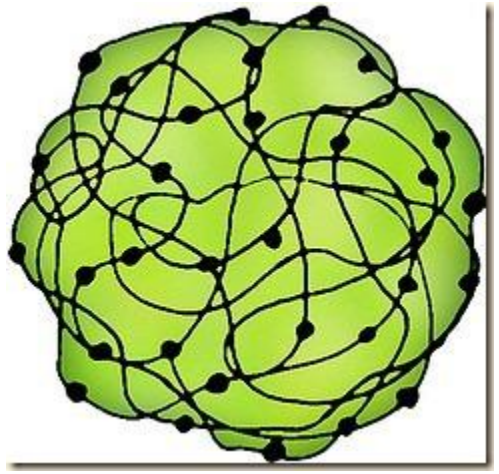
We need both reflection & immersion



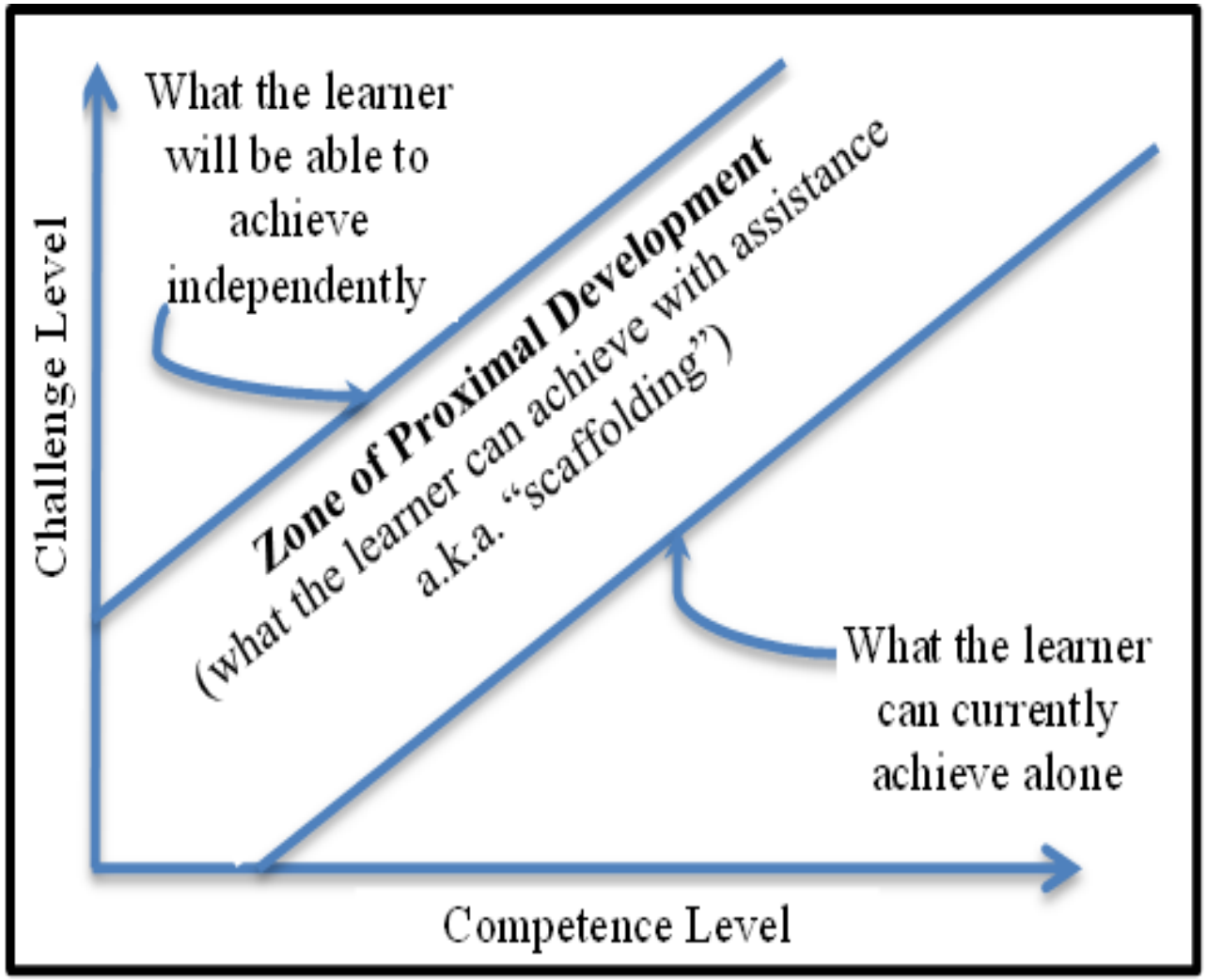


When do you allow your mind to wander?

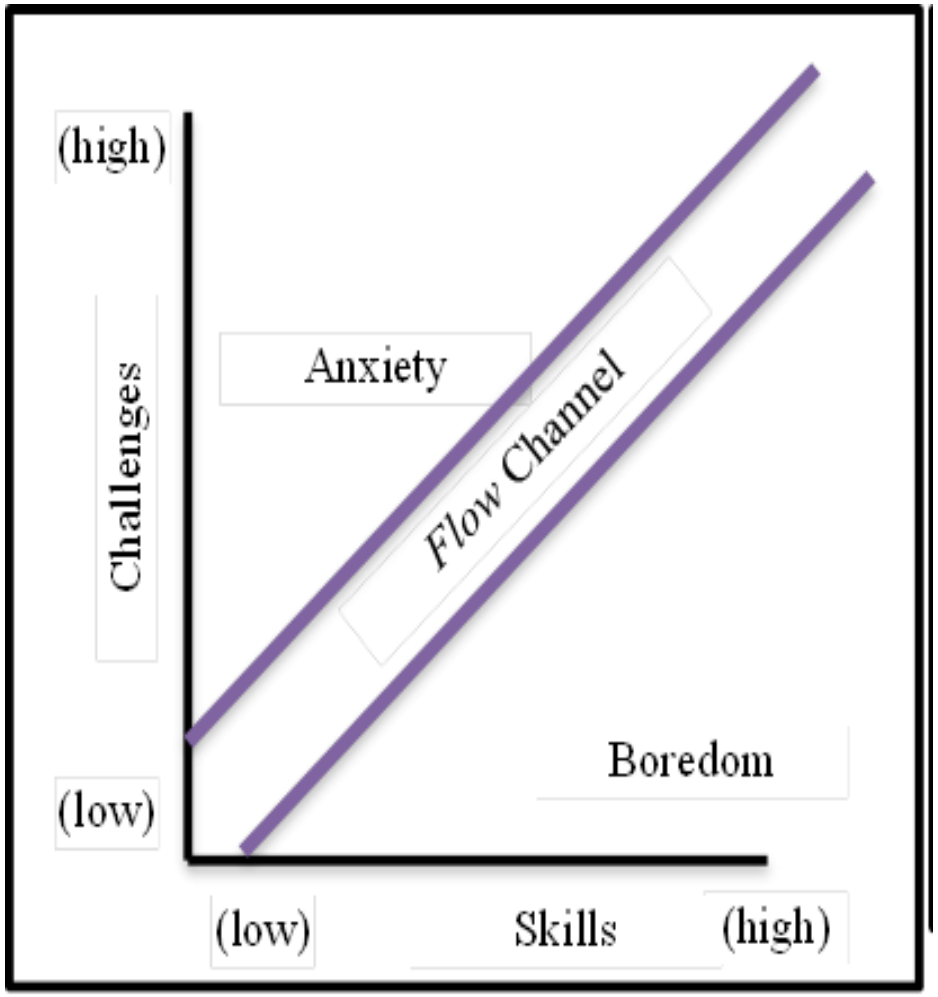
Why is this important?



Vygotsky and the Zone of Proximal Development (ZPD)



Flow by Csikszentmihalyi



What are you doing when you report being the happiest?

So what?

- Being self-aware about how you learn will help you learn (meta-cognition)
- Declarative memory requires sleep to encode;
- Blank Page Quizzing helps (creates a moment of error-driven learning)
- Skills (non-declarative memory) require repetition (encourages Hebbian / habit forming)
- Challenging yourself to learn more puts you in your ZPD – and also leads to ***flow***

The "So What" for Engineers

- Introducing people to a new design or system often **requires that they learn** how to use it.

- How can we design in ways that naturally work with how people learn, to reduce frustration / **increase usage of our work**?