Welcome to Day 1!

Train the Trainer: Principles of learning and how they apply to training and teaching

SciLifeLab Training Hub - Spring 2024

Course Leader - Jill Jaworski

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Train the Trainer Course Schedule

Day 1	**Wednesday, April 10** - 12:30-16:30 CET, over Zoom	**Introductions** **Principles of Teaching and Learning**
Day 2	Wednesday, April 17 - 12:30-16:30 CET, over Zoom	Designing and Planning Sessions
Day 3	Wednesday, April 24 - 12:30-16:30 CET, over Zoom	Enhancing Learner Participation and Engagement
Day 4	*Thursday, May 2 - 12:30-16:30 CET, over Zoom (May 1 is a holiday in Sweden)	Assessment and Feedback in Teaching and Learning

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Learning outcomes

By the end of this session, learners will be able to:

- **List** the steps of good instructional design.
- **Define** cognitive load.
- **Distinguish** between bad and good cognitive load.
- **Clarify** why we start with learning outcomes.
- **Give examples of** effective learning strategies.
- **Connect** learning strategies to the cognitive processes they promote.
- **Select** appropriate learning outcomes within the learning constraints.
- **Assess** your teaching outlook/practices in relation to what you've learned.
- **Design** learning experiences that align with learning outcomes.

Evidence-based learning principles

P1: Students' **differences** influence their world view, their learning, and their performance.

P2: **Prior knowledge** can help or hinder learning.

P3: The **organization of knowledge** influences how students learn and apply what they know.

P4: **Motivation** determines, directs, and sustains what students do to learn.

P5: To develop **mastery**, students must:

- acquire **component skills**
- practice **integrating** them
- know when to **apply** what they've learned

P6: **Goal-directed practice** with **targeted feedback** enhances the quality of learning.

P7: The **classroom environment** we create profoundly affects learning, positively or negatively.

P8: To become self-directed learners, students must learn to **monitor and adjust** their approaches.

What is learning?

Put your thoughts in the chat

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Learning is the process of acquiring new understanding, knowledge, behaviors, skills, values, attitudes, and preferences.

Learning

Non Associative Learning'	Habituation Sensitization
Active Learning	
Associative Learning	Operant Conditioning Classical Conditioning Observational Learning
Play	
Enculturation	
Episodic Learning	
E Learning and Augmented Reality Learning	
Rote Learning	
Meaningful or Deep Learning	
Formal and Informal Learning	
Tangential Learning	
Incidental Learning	
More...	

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permanence



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What is learning?

- there is no one size fits all approach to learning
- different individuals learn in different ways, for different KSAs
- learning is influenced by many (many!) factors

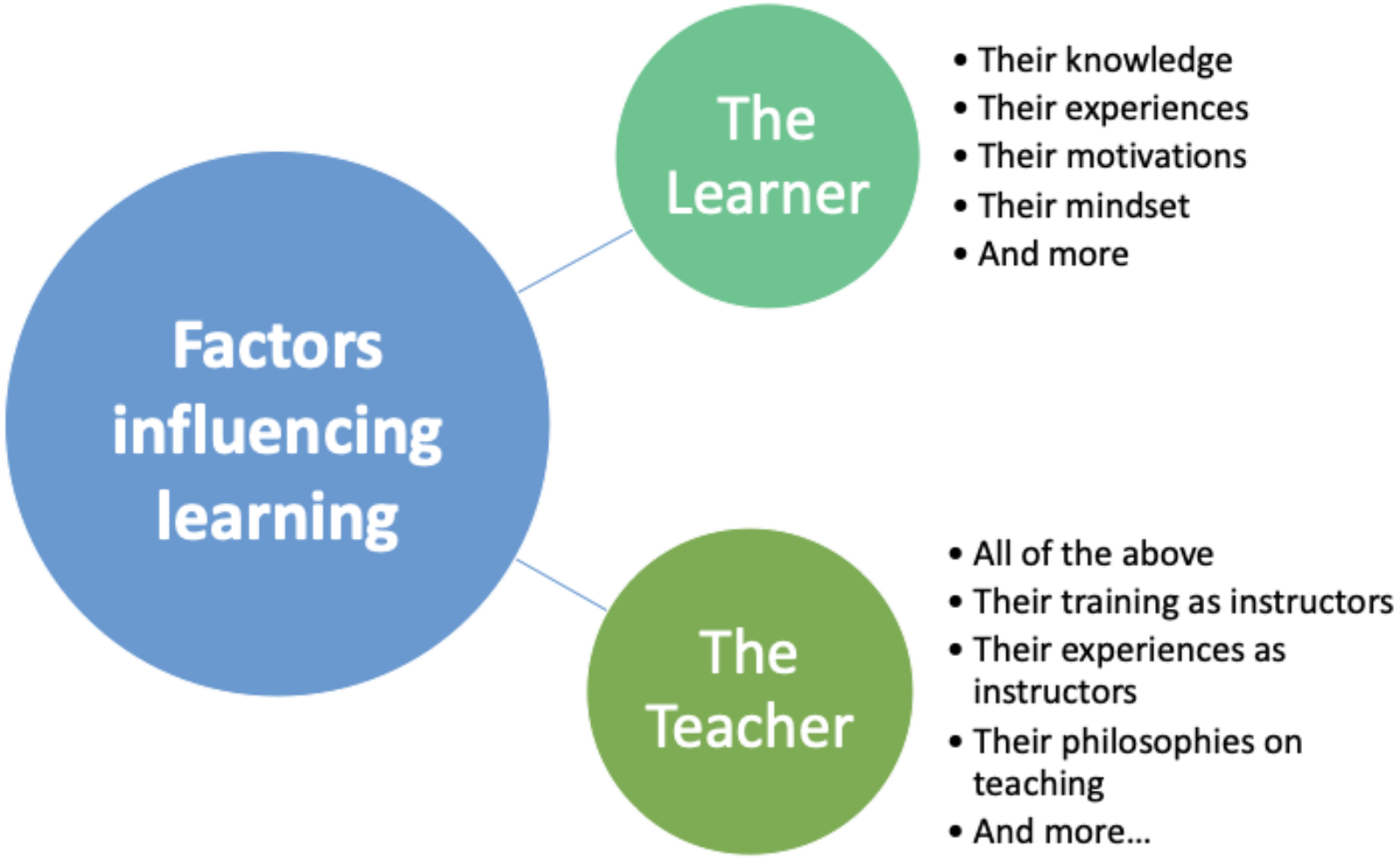
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What makes for a great…

Teacher, Training, Learning Experience, Student

Click on the shared document in the chat…

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Factors influencing learning
The Learner
• Their knowledge
• Their experiences
• Their motivations
• Their mindset
• And more
The Teacher
• All of the above
• Their training as instructors
• Their experiences as instructors
• Their philosophies on teaching
• And more…

The disconnect between teaching and learning

- effort does not necessarily create desired results
- past experiences shape our perceptions
- misconceptions shape our perspectives

Challenge 1.1 (3 min + 3 to discuss)

How do you approach learning?

What approach do you find most effective for learning new things? What about for other situations?

For example:

- read about it
- attend a training session
- try it out yourself
- a method to reflect, process or further understand
- something else?

Think about what works for you and **write** about it in the shared document.

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Traditional approaches



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Why should we learn about learning?

Intuitive ≠ effective

~~transmission (lecturing)~~

~~taking notes~~

~~summarizing~~

~~highlighting~~

~~rereading~~

?

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"The value of an education.. is not the learning of many facts but the training of the mind to think something that cannot be learned from textbooks."

- Einstein (actually)

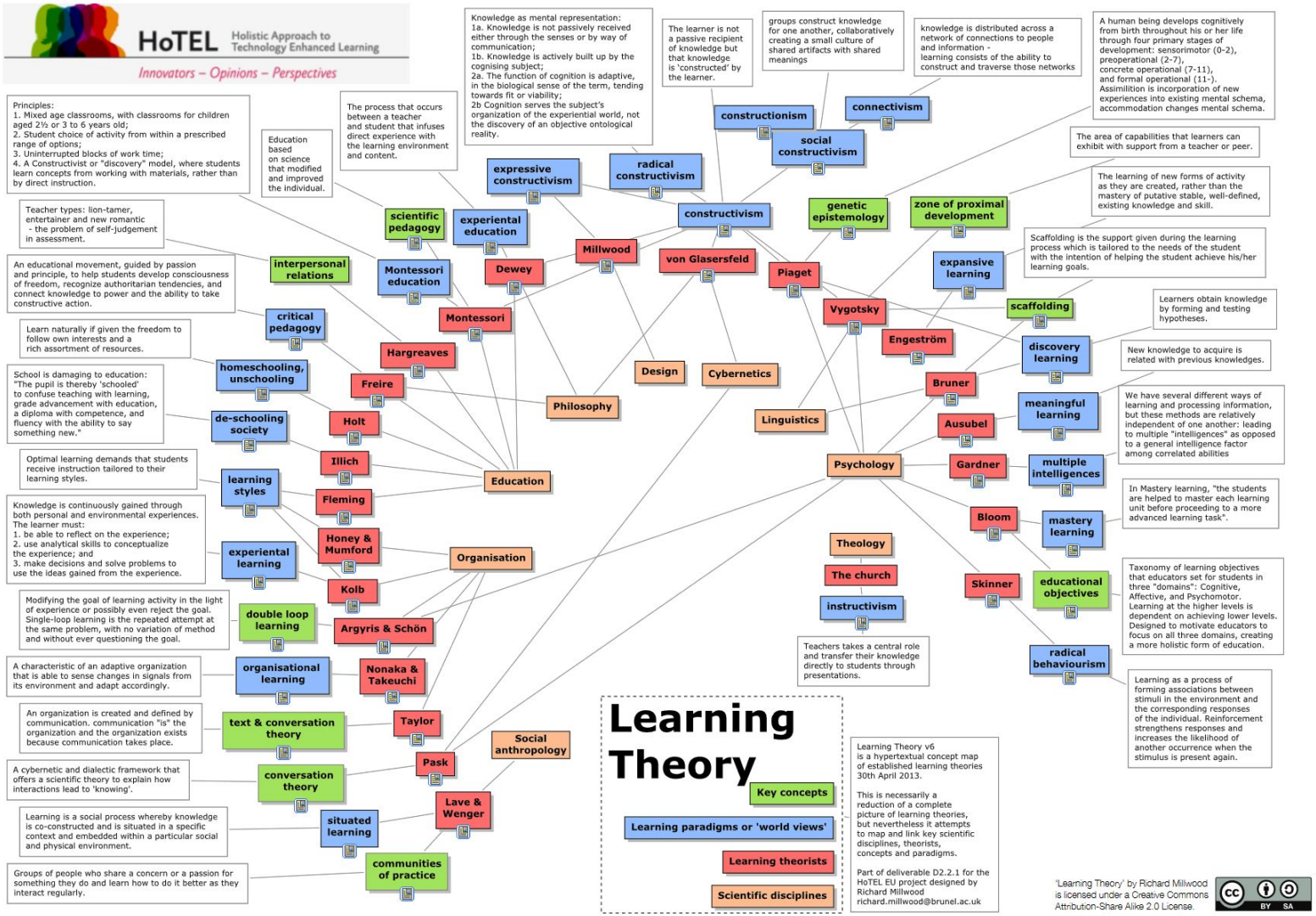
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BREAK (10 min)



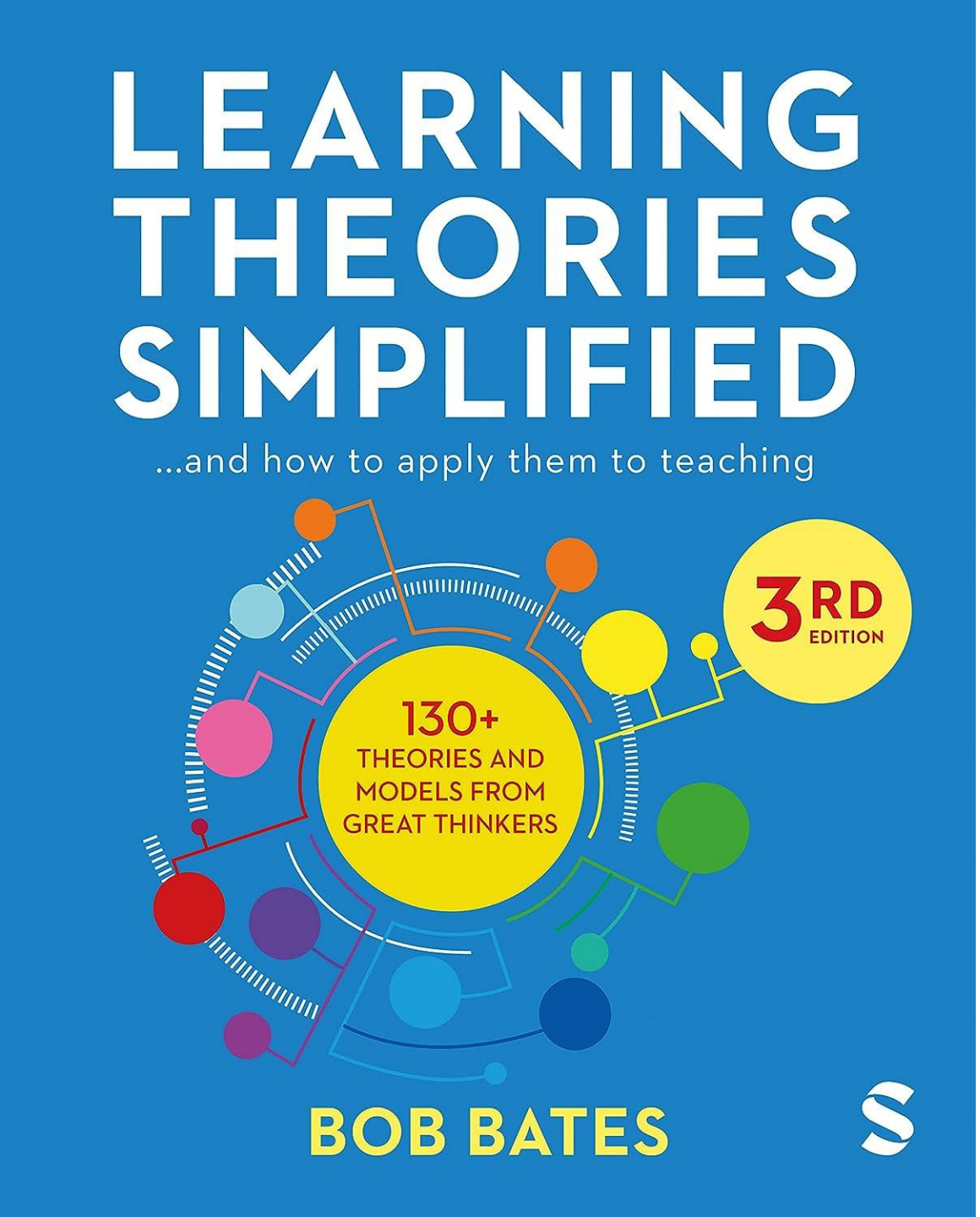
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Landscape of available learning theories



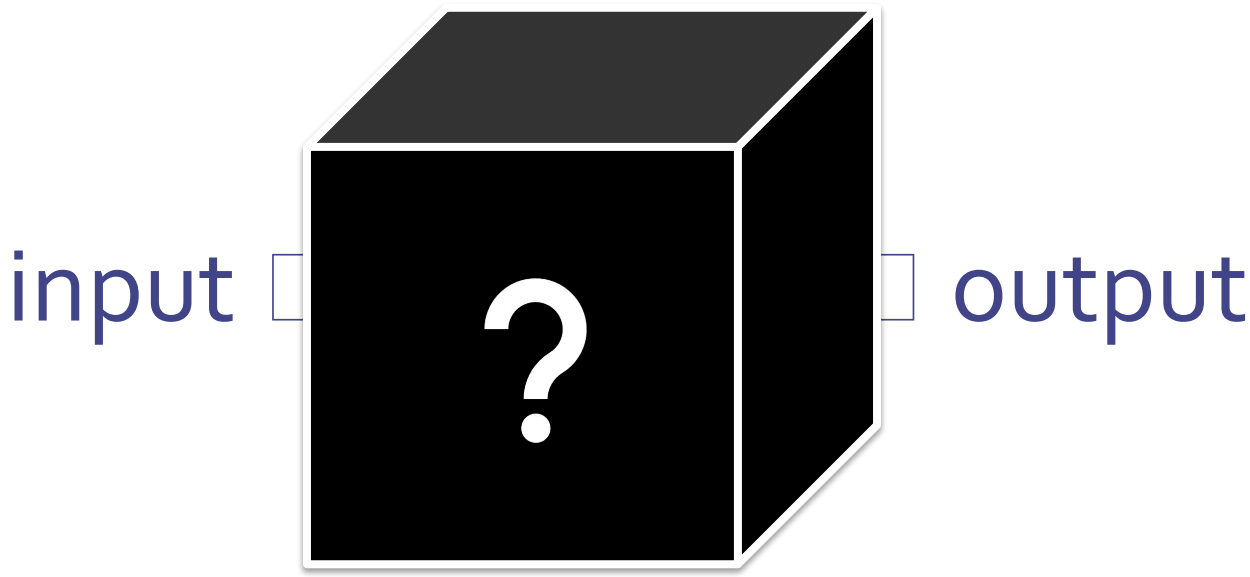
HoTEL project - diagram of learning theories (pdf)

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behaviorism
constructivism
cognitivism

Behaviorism: overview



learning: a change in observable behavior

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Classical conditioning

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bell □ (neutral)



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Or in Maestro's case…

Garage door = Neutral
Being let out = Excitement
Garage door + Being let out = Excitement
Garage door = Excitement

bell = (neutral)
food = salivation
bell + food = salivation
bell = salivation



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Can you think of a way classical conditioning shows up in classroom learning?

Put your thoughts in the chat

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Operant conditioning

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Behaviorism: positive reinforcement

good stimuli increase behavior

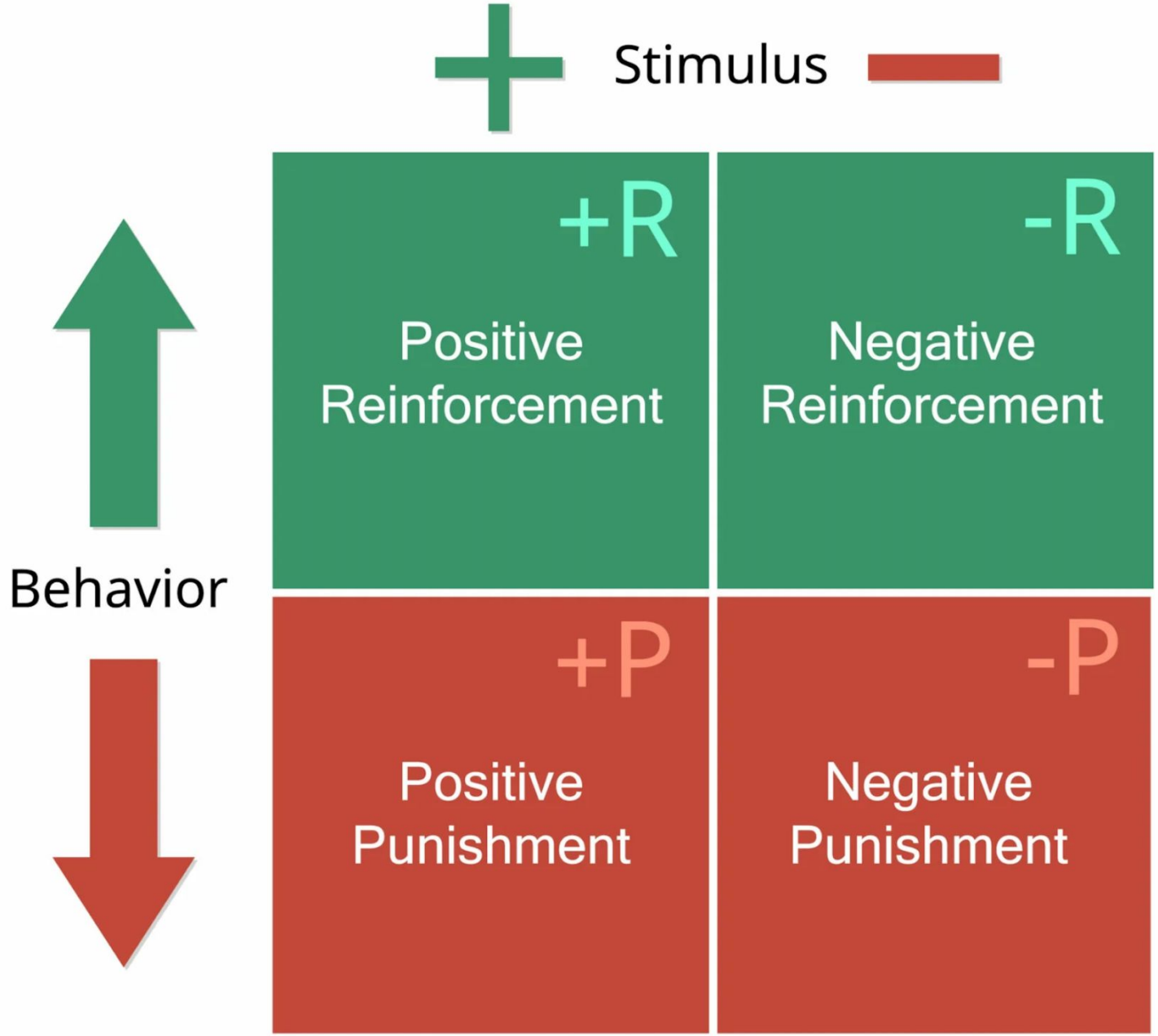
Behaviorism: negative reinforcement

escaping or avoiding bad stimuli increases behavior

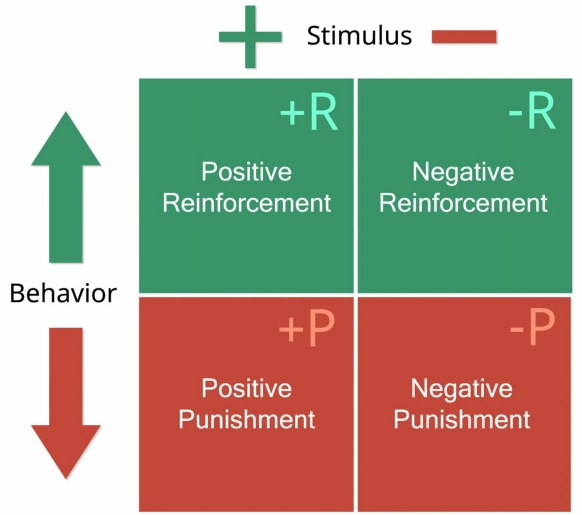
Behaviorism: punishment

bad stimuli decrease behavior

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Stimulus
+R
Positive Reinforcement
-R
Negative Reinforcement
Behavior
+P
Positive Punishment
-P
Negative Punishment

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Can you think of a way operant conditioning shows up in classroom learning?

Put your thoughts in the chat

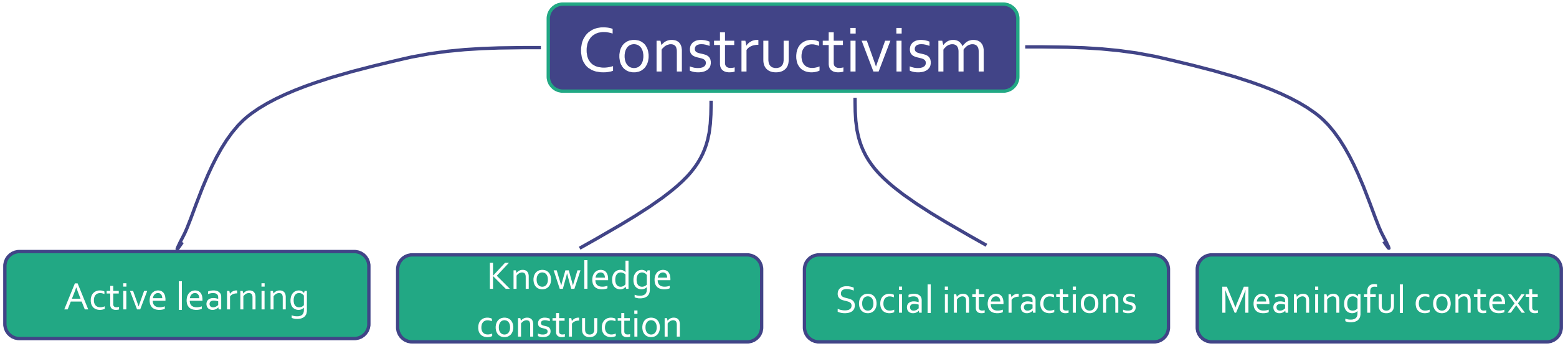
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Limitations of behaviorism

limited application
based on objective observation
no interest in “why”
hard to implement
hard to maintain

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Constructivism: overview



learning: making sense of experiences

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Psychological constructivism

feathers

fly



beaks

warm-blooded

lay eggs

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Psychological constructivism

feathers

~~fly~~



beaks

warm-blooded

lay eggs

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Social constructivism



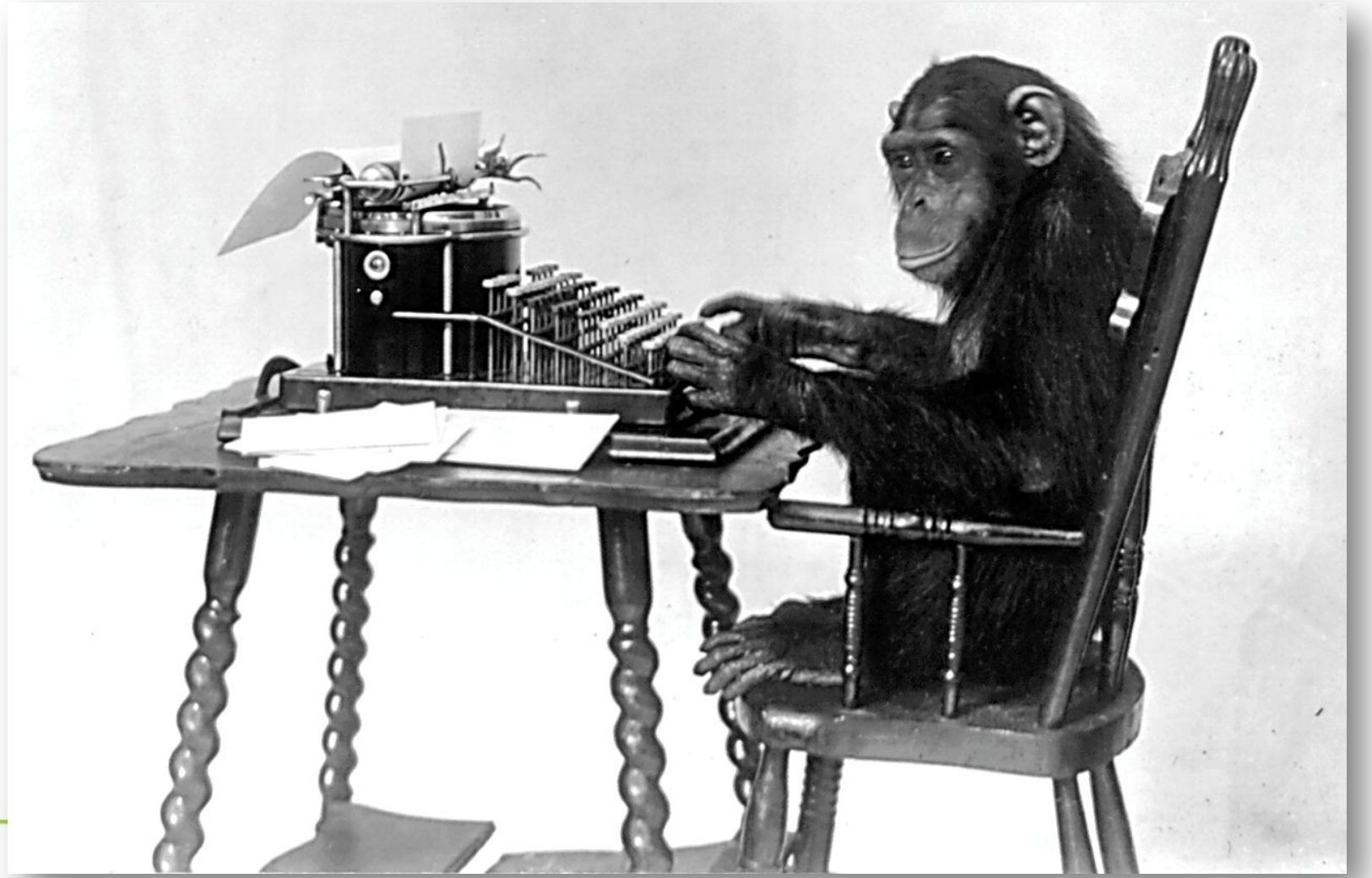
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In a collaborative setting, how could students' differences be beneficial to learning? How could they be a detriment?

Put your thoughts in the chat

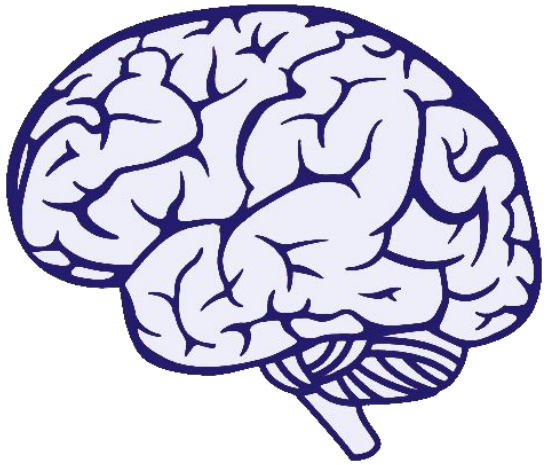
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Limitations of constructivism



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Cognitivism: overview

input □  □ output

learning: a change in mental structures and schemas

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Evidence-based learning principles

P1: Students' **differences** influence their world view, their learning, and their performance.

P2: **Prior knowledge** can help or hinder learning.

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P8: To become self-directed learners, students must learn to **monitor and adjust** their approaches.

Metacognition

P8: To become self-directed learners, students must learn to **monitor and adjust** their approaches.

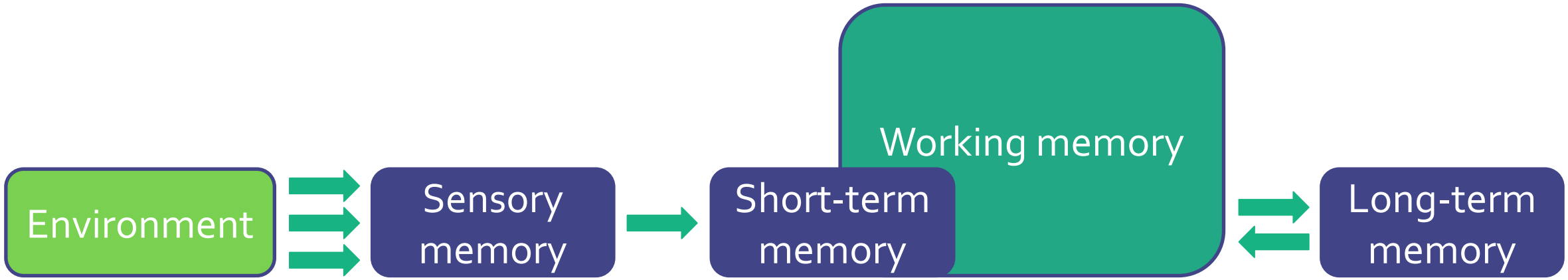
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BREAK (10 min)



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Types of memory



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Short-term vs long-term memory



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Challenge 1.2 (3 min + 3 to discuss)

Memory in daily life

Give an example from your day-to-day life where you use **working memory** and **long-term memory**.

Examples:

- working memory: keeping a phone number in your head while you dial it
- long-term memory: remembering your parents' phone number(s) without checking

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Challenge 1.3

How short is short-term memory?

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APH D BDN A CKG B DCI A

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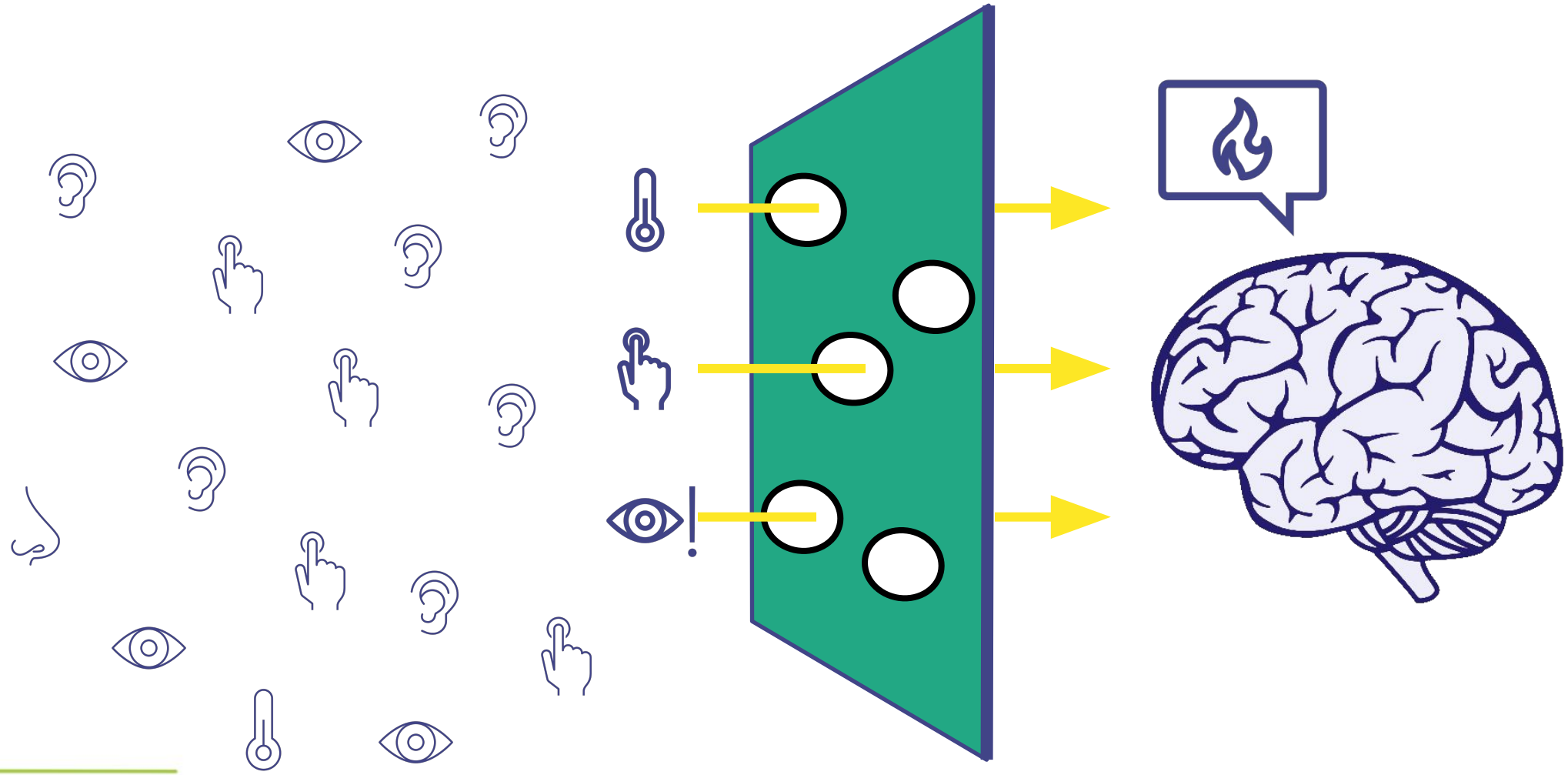
Challenge 1.3 (1 min)

How short is short-term memory?

Write them down :)

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The attention filter for sensory input



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CMLXD

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Perception



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CMLXD

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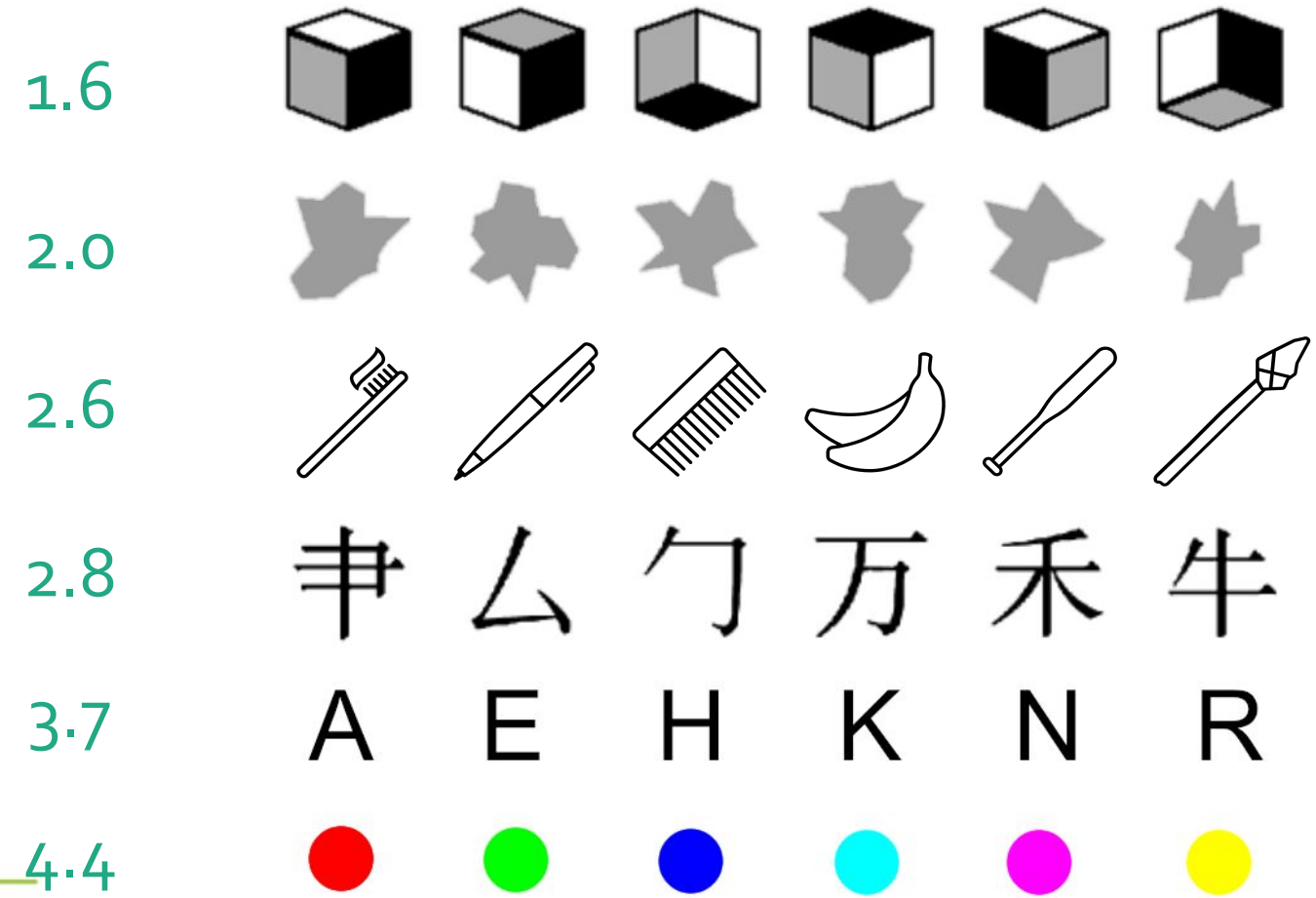
Knowledge organization

P2: **Prior knowledge** can help or hinder learning.

P3: The **organization of knowledge** influences how students learn and apply what they know.

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How short is short-term memory?



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Alvarez GA, Cavanagh P. The capacity of visual short-term memory is set both by visual information load and by number of objects. Psych Sci. 2004;15(2):106-11.

BREAK (5 min)



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Challenge 1.4 (5 min + 3 to discuss)

How can you avoid overloading working memory?

Breakout Rooms: 5 room x 5-6 people

In groups, discuss something a teacher could do to avoid overloading their students' working memory.

Write your proposal in the shared notes.

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Cognitive load

the total amount of mental effort used in working memory

https://www.mindtools.com/pages/article/cognitive-load-theory.htm

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Managing intrinsic load

segmentation

pretraining

advance organizers

other ideas?

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Challenge 1.5 (1 min)

Short-term memory: revisited

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A PHD B DNA C KGB D CIA

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How many **letters** do you remember?

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Chunking

4684026000

+46 8 402 6000

(this is the king's number)

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Challenge 1.6 (5 Breakout Rooms - 5 min + 3 to discuss)

Extraneous cognitive load

Think about the following learning environments:

- lectures
- group work
- classroom exercises

Discuss **examples of extraneous load** that might interfere with the experience and how you (the instructor) could **avoid** it. Add your thoughts to the shared document.

Extraneous load

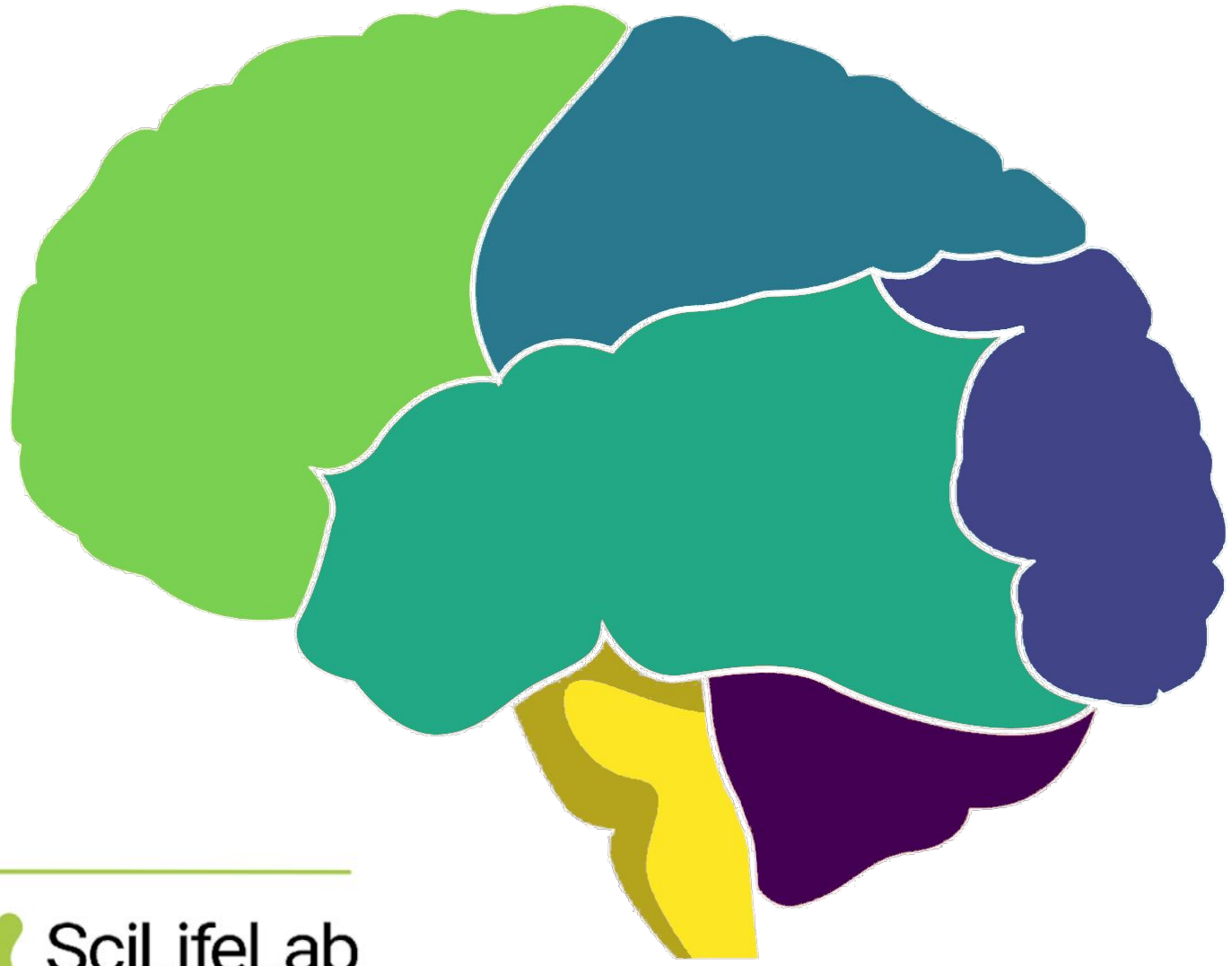
coherence: exclude extra material

signaling: highlight essential material

spatial/temporal contiguity: integrated presentation

redundancy: avoid redundant text and other distractions

Temporal and spatial (dis)contiguity



Occipital

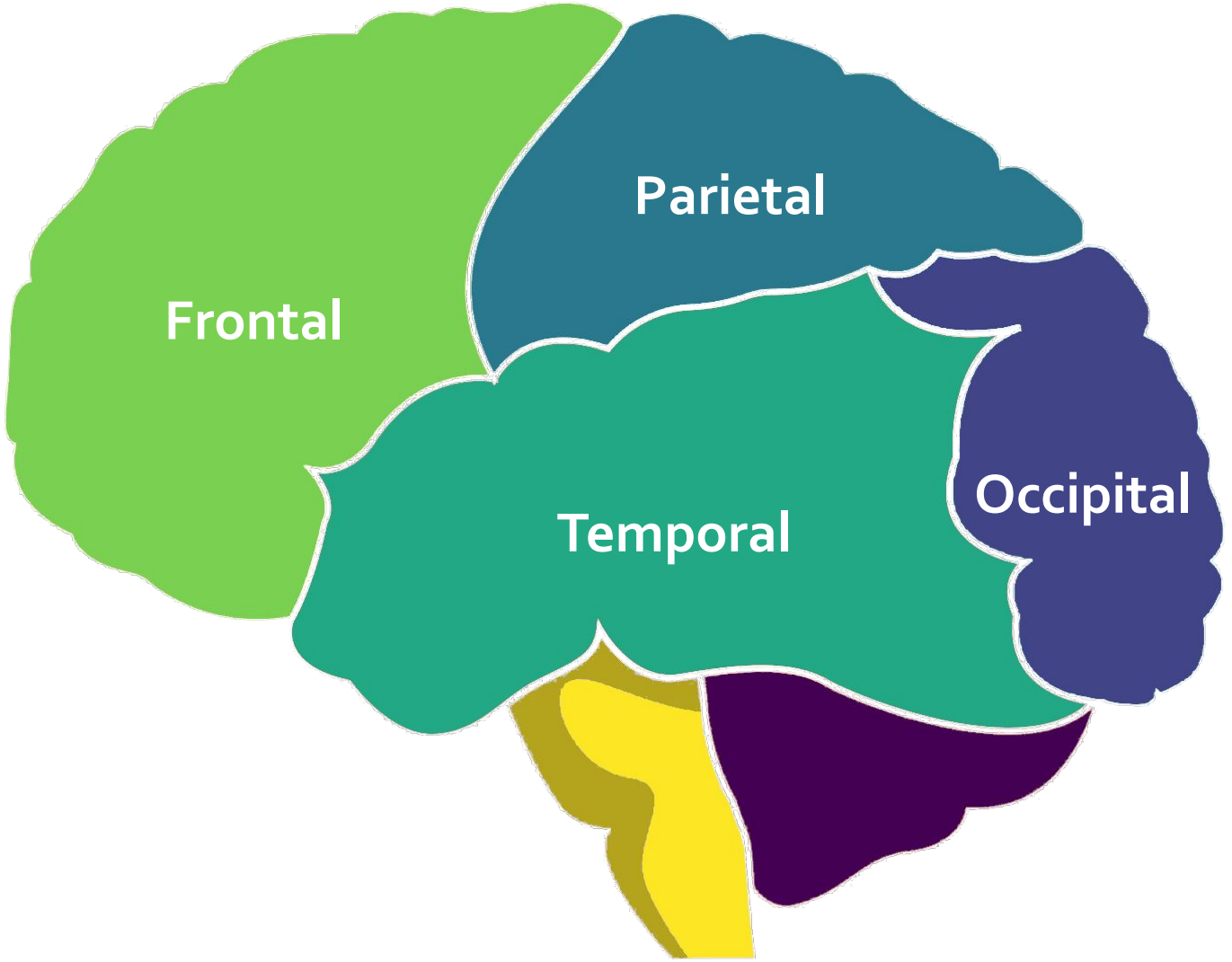
Parietal

Temporal

Frontal

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Split-attention



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Redundancy







The **redundancy effect** describes when the same information is presented in multiple formats at the same time or too much text is available (when a summary or outline would work just as well). People learn better from narration alone (compared to narration and printed text). This is especially true when narration is accompanied by graphics, possibly because the picture and the text are processed by the same visual "channel".

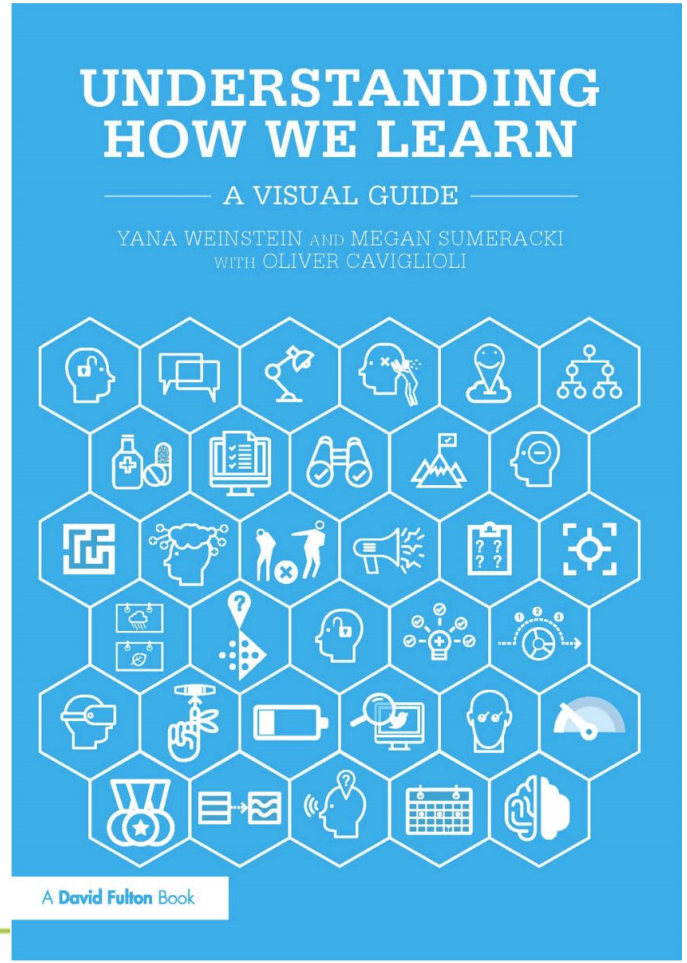
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BREAK (5 min)



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Germane load: 6 strategies



concrete examples

dual coding

interleaving

elaboration

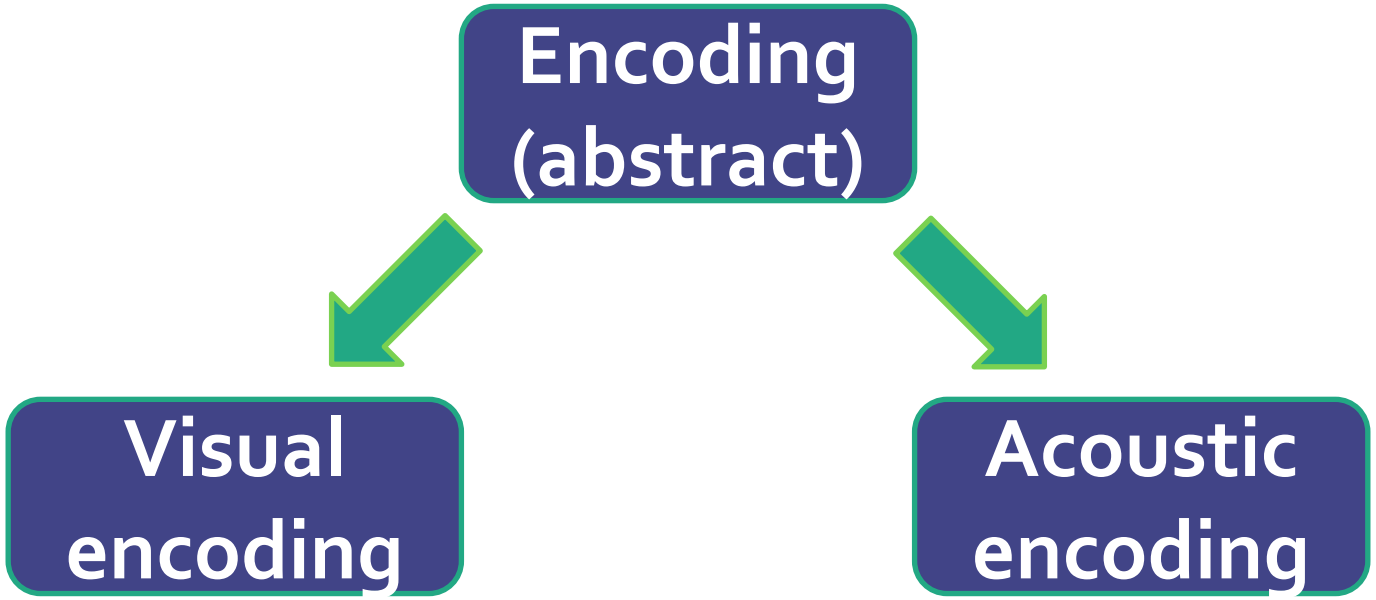
spaced practice

retrieval practice

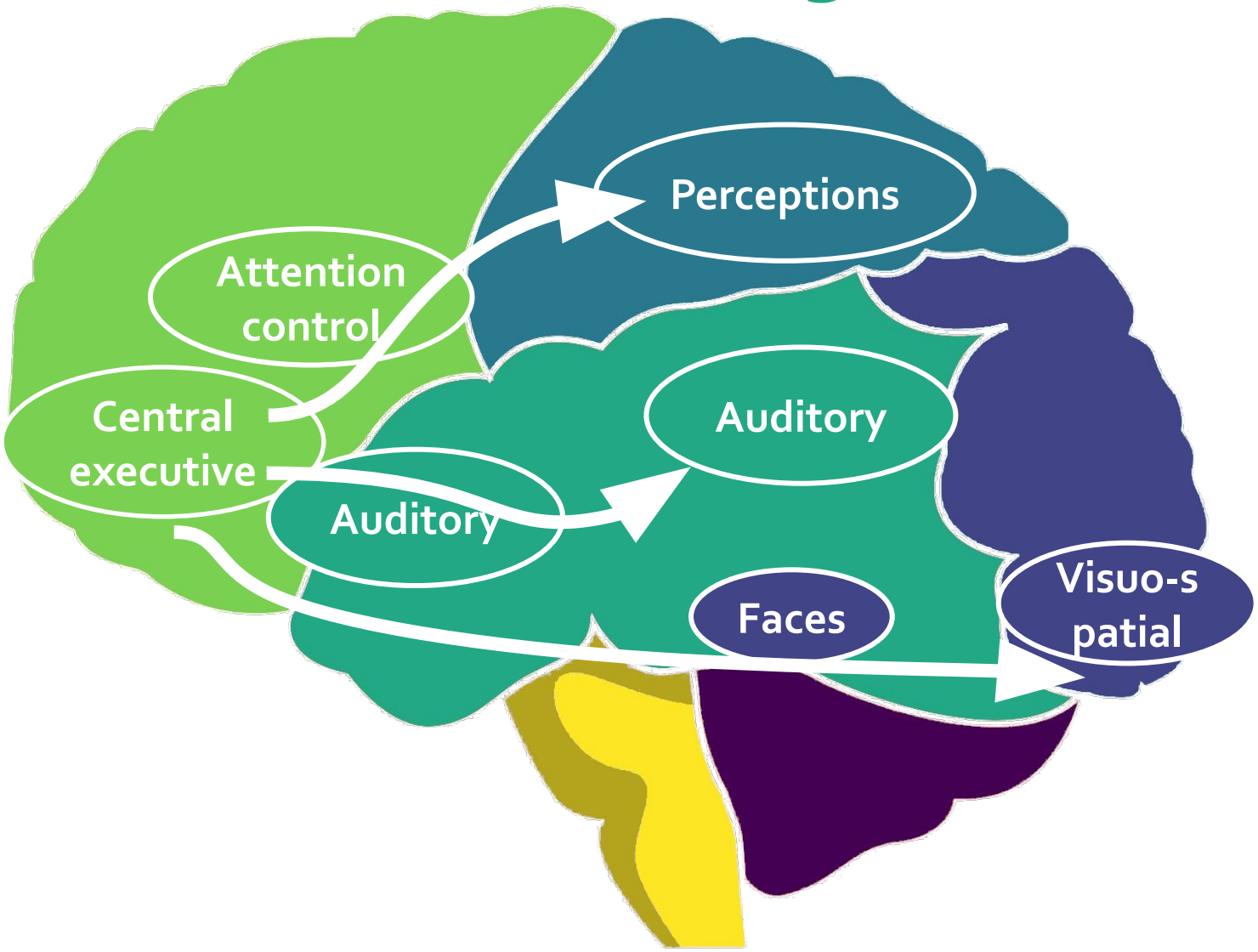
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The Learning Scientist - Six Strategies for Effective Learning: A Summary for Teachers (Megan Sumeracki)

Concrete examples



Dual coding



Adapted from 2010 Baddeley

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Blocked vs interleaved practice

Blocked practice

defining core concepts

highlighting common aspects

comparing highly dissimilar abstract categories

identifying similar items in diverse categories

listing similarities within one category

=

best for **novices**

Interleaving

practicing core concepts (motor behaviors)

relating concepts for problem-solving

distinguishing highly similar abstract categories

finely discriminating similar items

classifying

=

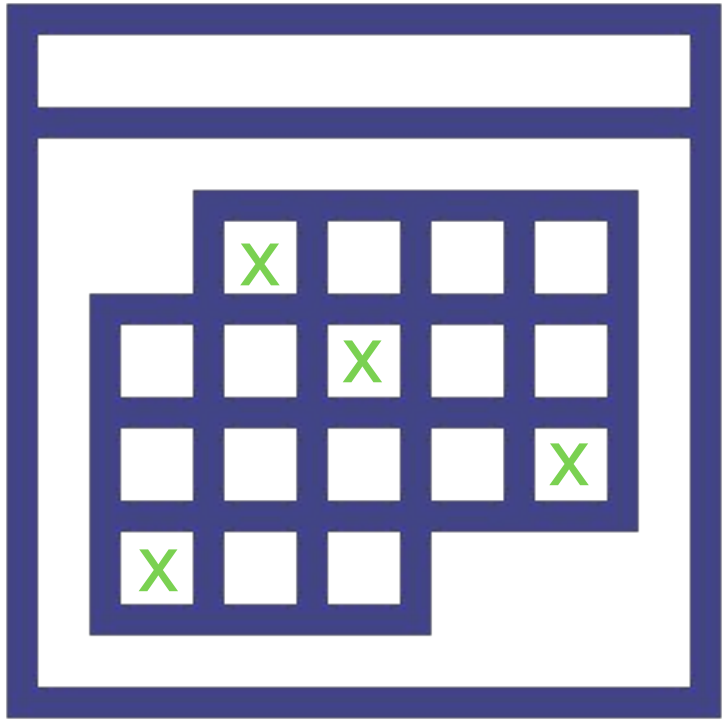
best for **experienced learners** and **experts**

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Elaboration

Why?

Spaced practice



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Retrieval practice

P5: To develop **mastery**, students must:

- acquire **component skills**
- practice **integrating** them
- know when to **apply** what they've learned

P8: To become self-directed learners, students must learn to **monitor and adjust** their approaches.

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Challenge 1.7 (8 min + 3 to discuss)

How do you understand the 6 strategies?

concrete examples | dual coding | interleaving | elaboration | spaced practice | retrieval practice

Work in groups of 2 to discuss a learning strategy.

Did you understand it the same way? Do you have questions?

Provide examples of how you could implement it as an instructor.

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BREAK (5 min)



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But why mental models?

understanding

problem-solving

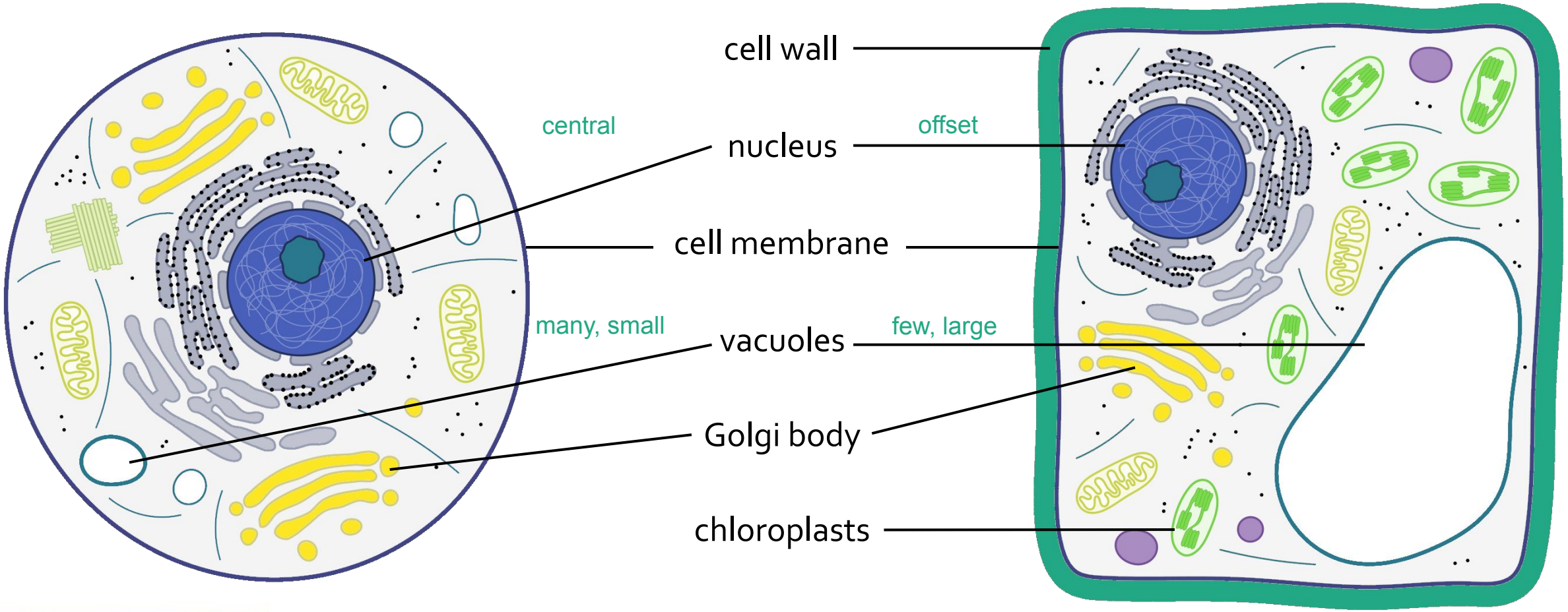
decision-making

learning

communication

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Knowledge representation: schemas

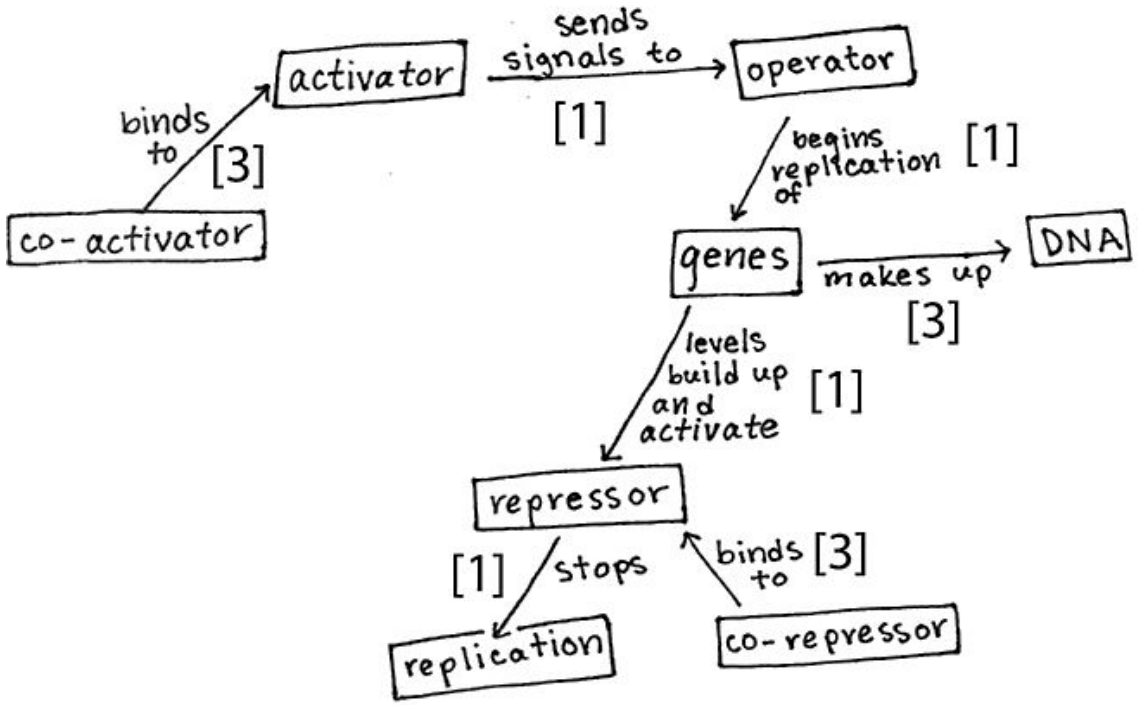


animal

plant

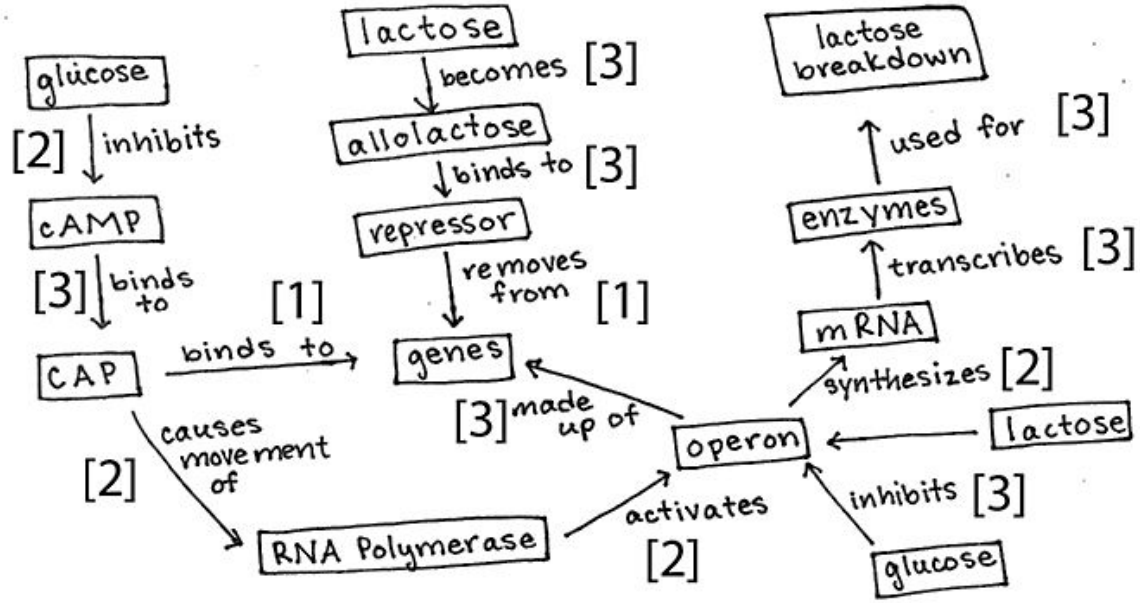
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Concept mapping of a mental model



before lesson

average correctness = 1.9



after lesson

average correctness = 2.4

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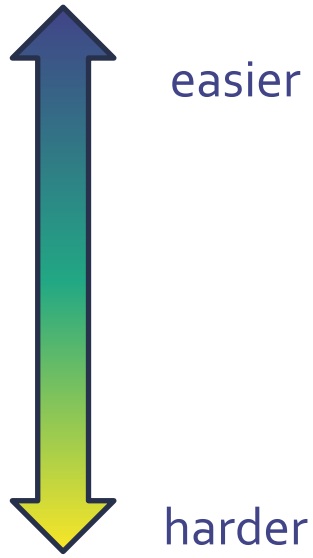
Dauer JT et all. Changes in students' mental models from computational modelling of gene regulatory networks. Int J STEM Educ. 2019;6(38).

Broken mental models: misconceptions

simple factual errors

broken models

fundamental beliefs



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Dreyfus model of skills acquisition



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Progression: components



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Progression: perspective



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Progression: decision



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Progression: commitment



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Integrating the Dreyfus model

Principles of knowledge

Learning theories

Memory, attention, and cognitive load

Strategies for effective learning

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Instructional design

Nicholl's 5-step model

Knowledge, skills, abilities

Learning outcomes and assessable verbs

Bloom's taxonomy

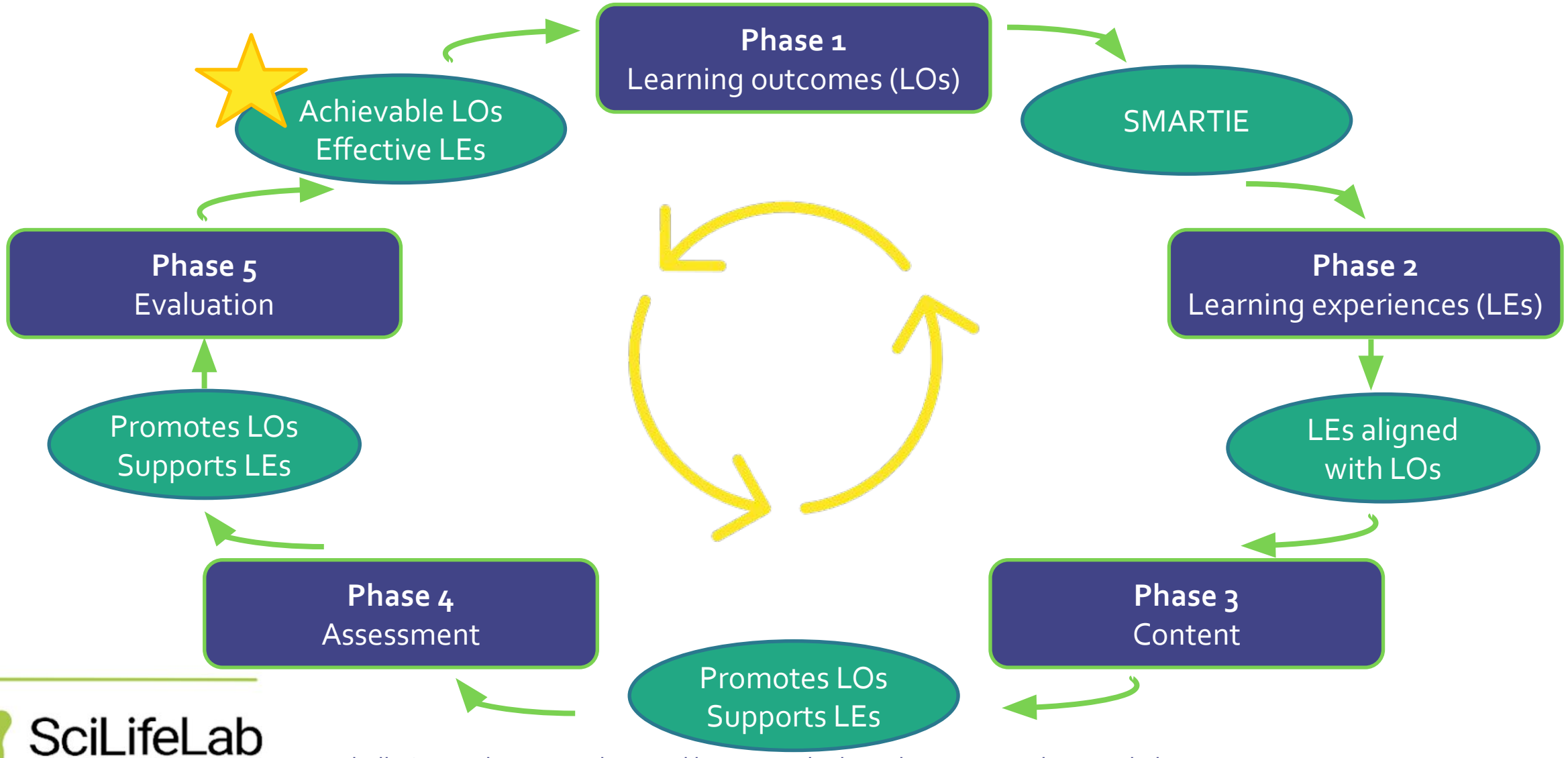
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BREAK (5 min)



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Nicholl's 5-steps



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Nicholls G. Developing teaching and learning in higher education. London:Routledge;2002.

Phase 1

1. Define the learning outcomes (LOs)

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Specificity of objectives

	Teaching goals	KSAs	Learning outcomes
Scope	broad	moderate	narrow
Time needed	year(s)	weeks/months	hours/days
Purpose	provide vision	design curriculum	prepare lesson plans
Example of use	plan a learning path	plan units of instruction	plan daily experiences

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Knowledge, Skills, Abilities (KSAs)

Identify the set of KSAs

Example:

- knowledge of learning principles
- skills to adapt your curriculum based on what you've learned
- ability to evaluate prior knowledge in your students

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Operational definitions of LOs

: statements expressing the KSAs that can be **demonstrated** upon LE completion

: what learners will learn and the instructor can **assess**

https://irds.stanford.edu/assessment/assessment-overview/assessment-tools

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Writing SMARTIE learning outcomes

S pecific
M easurable
A chievable
R elevant
T ime-limited
I nclusive
E quitable

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Writing LOs with assessable verbs

Avoid verbs that are:

unassessable

unmeasurable

open to interpretation

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Frameworks and taxonomies

framework: distinct categories

taxonomy: continuum of categories

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Bloom's taxonomy: cognitive complexity



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Taxonomy of verbs

Create	assemble, build, collect, combine, compile, compose, constitute, construct, design, develop, devise, formulate, generate, hypothesize, integrate, invent, make, manage, modify, **organize**, **perform**, plan, prepare, produce, propose, rearrange, reconstruct, reorganize, revise, rewrite, synthesize, write
Evaluate	advise, appraise, argue, assess, **compare**, **conclude**, consider, contrast, convince, correct, criticize, critique, decide, **defend**, determine, discriminate, grade, judge, justify, measure, rank, rate, recommend, review, score, select, standardize, support, test, validate
Analyze	**arrange**, break down, **categorize**, **classify**, **compare**, **conclude**, connect, **contrast**, deconstruct, deduce, detect, diagnose, diagram, differentiate, discriminate, **distinguish**, divide, examine, **explain**, identify, integrate, **inventory**, **list**, order, **organize**, relate, separate, structure
Apply	calculate, carry out, change, choose, classify, complete, compute, construct, demonstrate, dramatize, employ, examine, execute, experiment, generalize, illustrate, implement, infer, interpret, manipulate, modify, operate, **organize**, outline, **perform**, predict, solve, transfer, translate, use, verify
Understand	**arrange**, associate, **categorize**, clarify, **classify**, **compare**, **conclude**, **contrast**, **defend**, diagram, differentiate, discuss, **distinguish**, estimate, exemplify, **explain**, express, extend, extrapolate, generalize, give examples of, illustrate, infer, interpret, match, outline, paraphrase, predict, rephrase, represent, **restate**, summarize, transform, translate
Remember	cite, define, describe, identify, **inventory**, label, **list**, match, name, outline, quote, recall, recognize, report, reproduce, **restate**, retrieve, show, state, tell

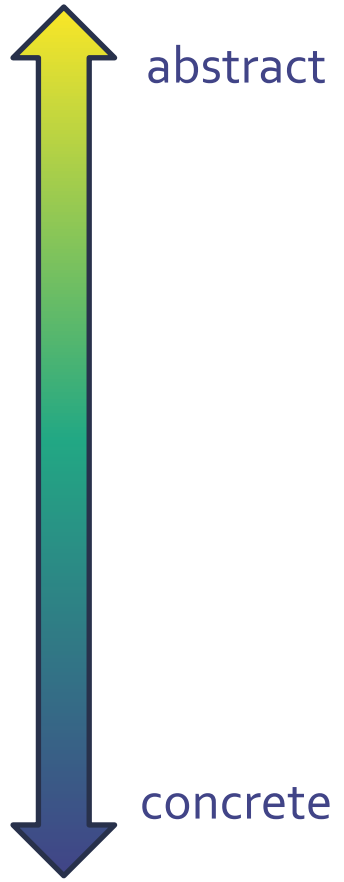
Expanded taxonomy: knowledge dimension

metacognition

procedures

concepts

facts



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A taxonomy table

Metacognitive						
Procedural						
Conceptual						
Factual						
	Remember	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**

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A taxonomy table

Metacognitive						
Procedural						
Conceptual						
Factual	1					
	Remember	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**

1. **List the steps** of good instructional design

A taxonomy table

Metacognitive						
Procedural						
Conceptual		2				
Factual	1					
	Remember	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**

1. **List the steps** of good instructional design.
2. **Distinguish** between good and bad **cognitive load**.

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A taxonomy table

Metacognitive						
Procedural				3		
Conceptual		2		3		
Factual	1					
	Remember	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**

1. **List the steps** of good instructional design.
2. **Distinguish** between good and bad **cognitive load**.
3. **Connect learning strategies to the cognitive processes** they promote.

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A taxonomy table

Metacognitive					4	
Procedural				3		
Conceptual		2		3		
Factual	1					
	Remember	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**

1. **List the steps** of good instructional design.
2. **Distinguish** between good and bad **cognitive load**.
3. **Connect learning strategies to the cognitive processes** they promote.
4. **Assess your teaching outlook in relation to what you've learned**.

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Implications for classroom teaching

learning

instruction

assessment

alignment

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Learning experiences

lecture: remember, understand

exercise: apply, analyze

group discussion: analyze, evaluate

?

Challenge 1.9 (3 min + 3 to discuss)

Identify LEs and assessments aligned with LOs

Breakout Rooms: 8 groups of 3-4

Pick one learning outcome and identify a learning experience and an assessment aligned with that LO. Write them in the shared document.

By the end of this course, you should be able to:

list the planets of the solar system

explain the difference between a nut and a berry

develop a short programming script (in *x* language)

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Questions and feedback

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Homework

Reflection

How do you understand the 6 strategies for effective learning?
How do you understand the 8 principles of learning?
Reflect for the next session

Choose a topic to demonstrate your training in 3 minutes; you'll prepare for next time.

Examples:

how to make an origami bird

intro to biochemistry

how bats recognize obstacles

the second law of Newton

how to draw a comic strip

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Resources

Bob Bates. Learning theories simplified… and how to apply them to teaching. 3rd ed (2023).

James M. Lang. Small teaching: everyday lessons from the science of learning. 2nd ed (2021).

Marsha C Lovett, Michael W Bridges, Michele DiPietro, Susan A Ambrose, Marie K Norman. How learning works: 8 research-based principles for smart teaching. 2nd ed (2023).
PDF overview of How learning works

The carpentries: instructor training. https://carpentries.github.io/instructor-training/

Yana Weinstein, Megan Sumeracki, Oliver Caviglioli. Understanding how we learn: a visual guide. 1st ed (2018).

See you on Wednesday, April 17!

Before you go: Please fill out the Feedback Form that is in the chat!

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