Evidence-Based Learning Strategies from Cognitive Science

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Cindy Nebel & Megan Sumeracki

August 11, 2025

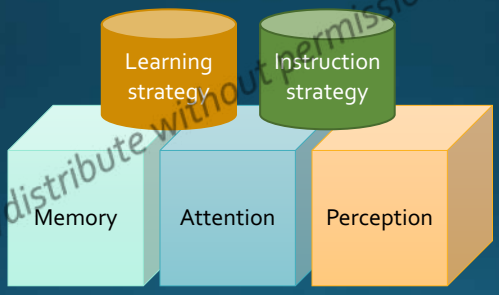
@AceThatTest

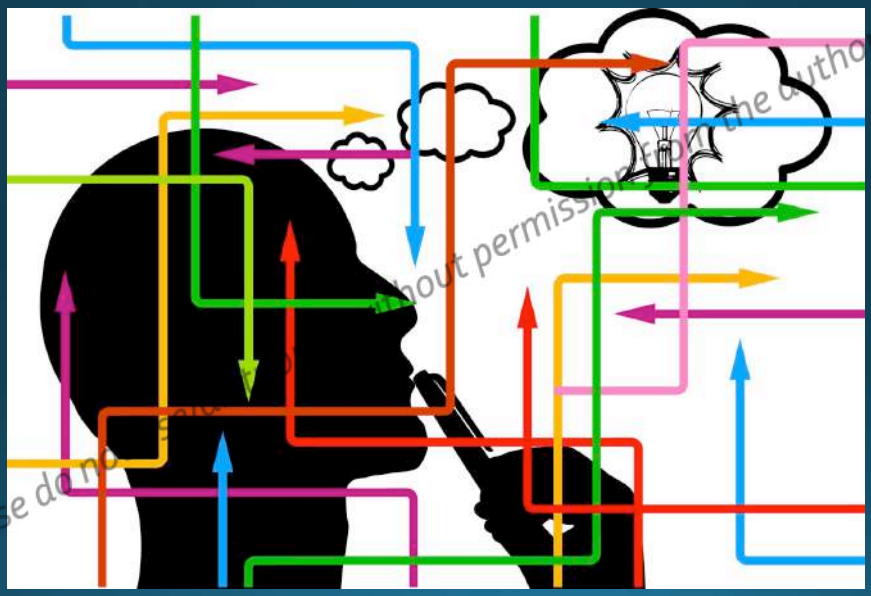
www.learningscientists.org

Overview

- Cognition applied to EDU
- Plan: Spacing & Interleaving
- Understand: Elaboration, Concrete Examples, Dual Coding
- Reinforce: Retrieval Practice
- Free Resources
- After Lunch: Apply!

How is Cognitive Psychology Applied to Education?

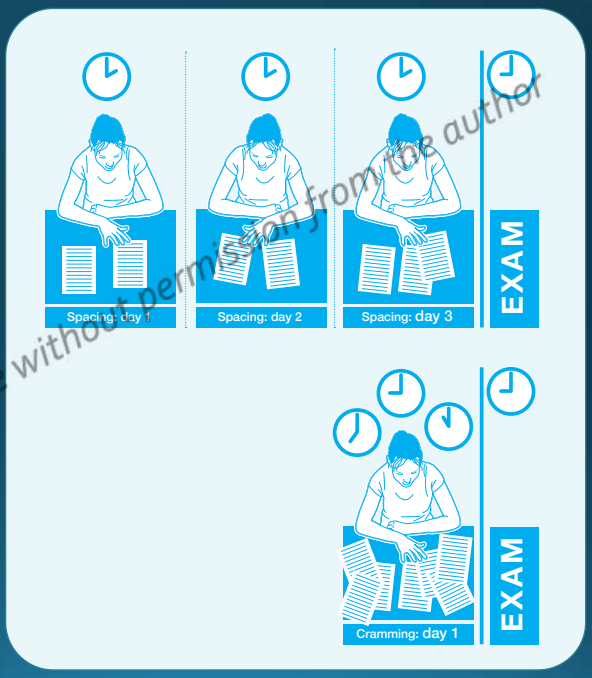




Plan

Spacing

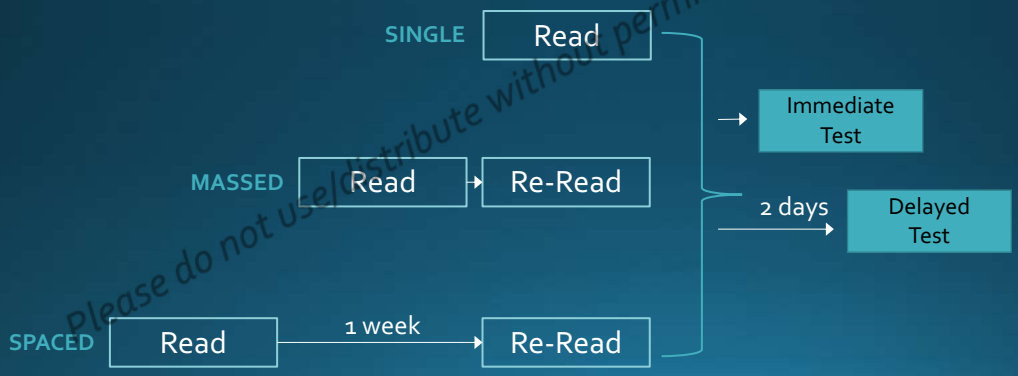
Main idea: Spacing



DEMO:
Solve these two math problems in your head

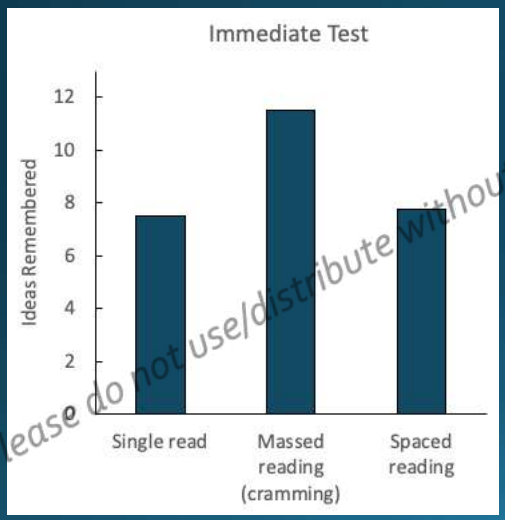
Evidence from the Laboratory

- Participants studied a lengthy science text



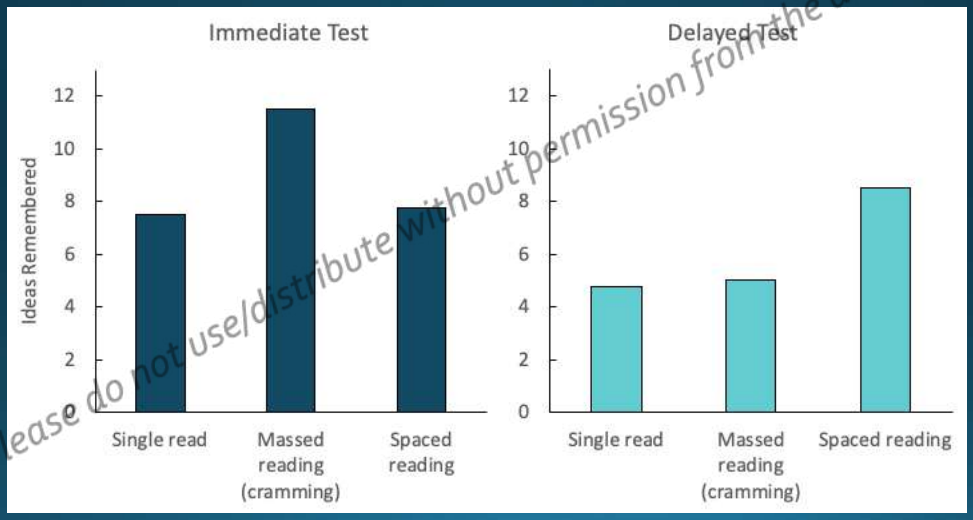
Rawson & Kintsch (2005)

Evidence from the Laboratory



Rawson & Kintsch (2005)

Evidence from the Laboratory



Rawson & Kintsch (2005)

Spacing – An All-rounder

Vocabulary learning
(e.g., Bahrick et al., 1993; Kornell, 2009; Bloom & Shuell, 1981)

Medical & Health CPD
(e.g., Van Hoof et al., 2021)

Surgical skills
(e.g., Moulton et al., 2006; Nakata et al., 2017)

Fact learning
(e.g., DeRemer & D'Agostino, 1974)

Works in many domains

Motor skills
(e.g., Baddeley & Longman, 1978; Shea et al., 2000; Goedert & Miller, 2008)

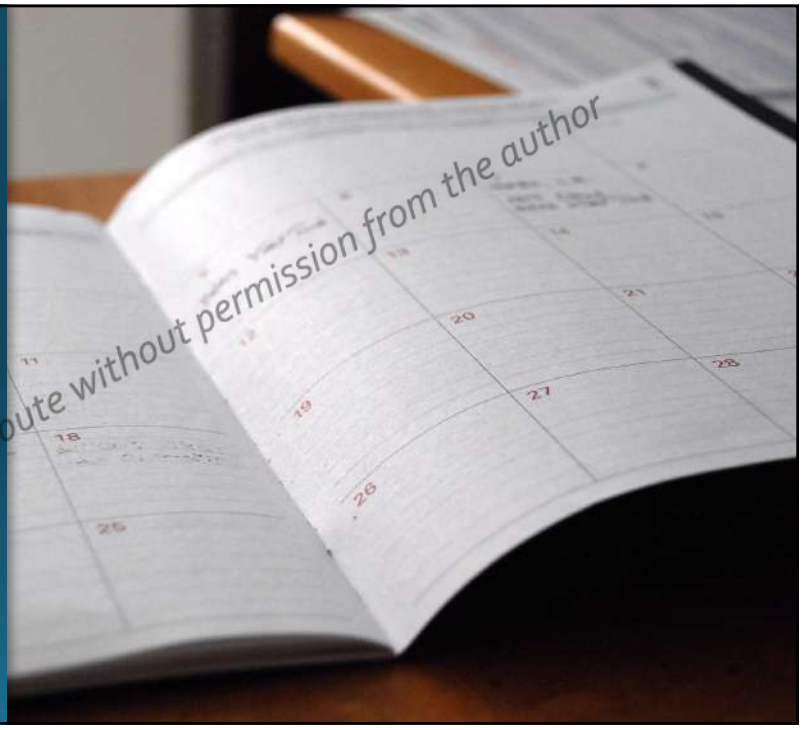
Text passages
(e.g., Gordon, 1925; Rawson & Kintsch, 2005; Verkoeijen et al., 2008)

Problem solving
(e.g., Cook, 1934; Grote, 1995)

Musical instrument learning
(e.g., Simmons, 2007)

Using Spacing

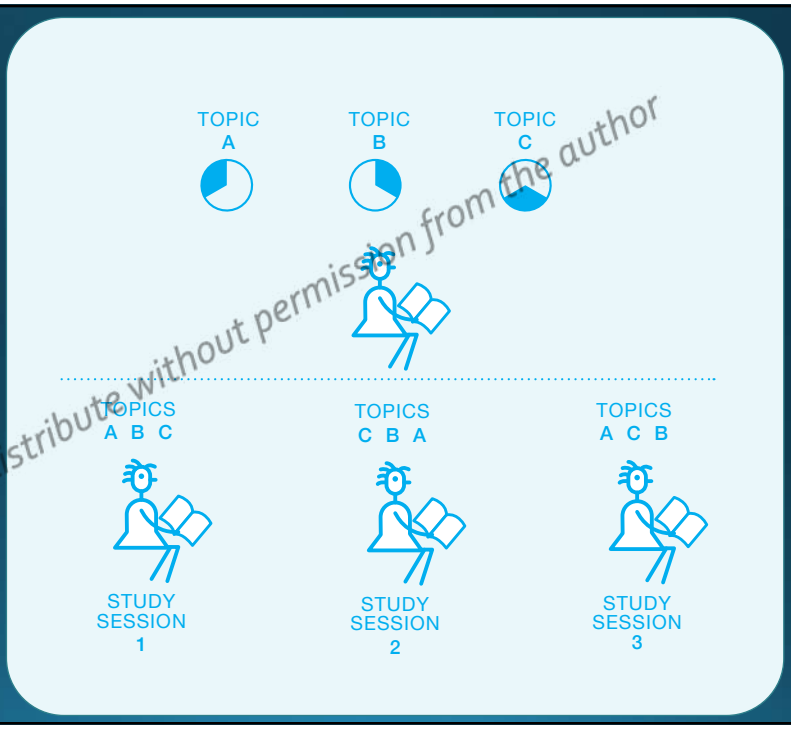
- Encourage students to study in little bits, spread out over time
- Give consistent, cumulative assignments
- Schedule reviews



Plan

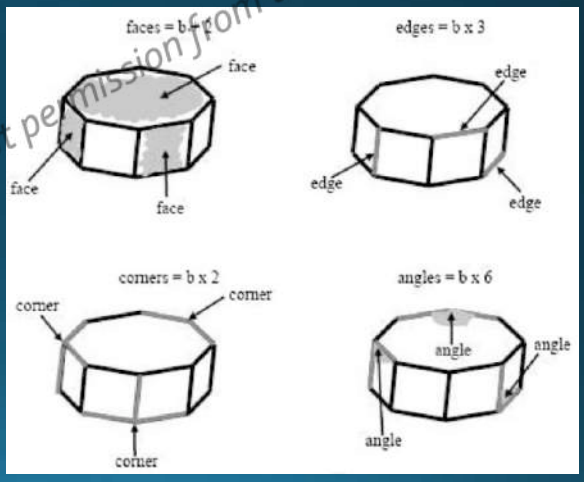
Interleaving

Main idea: Interleaving



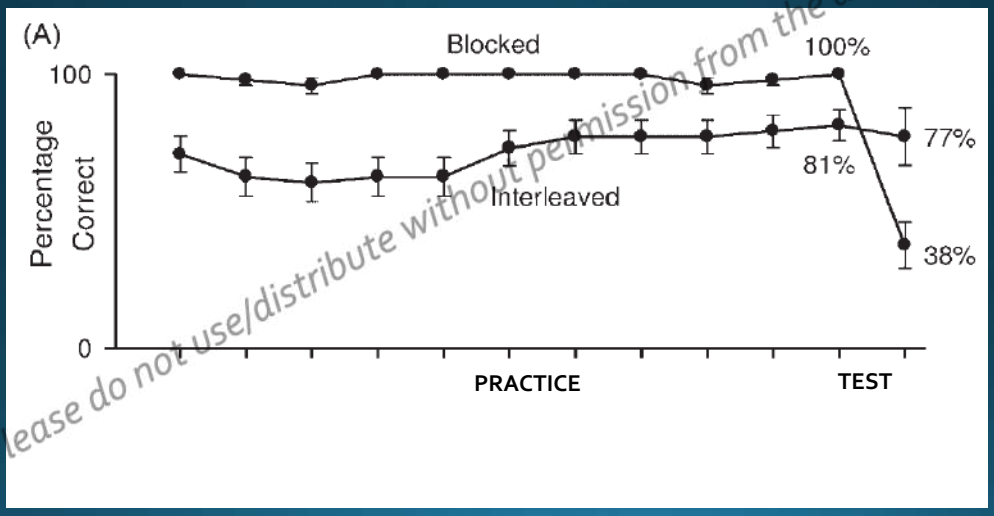
Interleaving in math learning

- Learned 4 different formulas
- Blocked Practice:
  AAAA BBBB CCCC DDDD
- Interleaved Practice:
  ABCD CADB DCBA BDAC
- Tested 1 day later



Taylor & Rohrer (2010)

Interleaving in math learning



Taylor & Rohrer (2010)

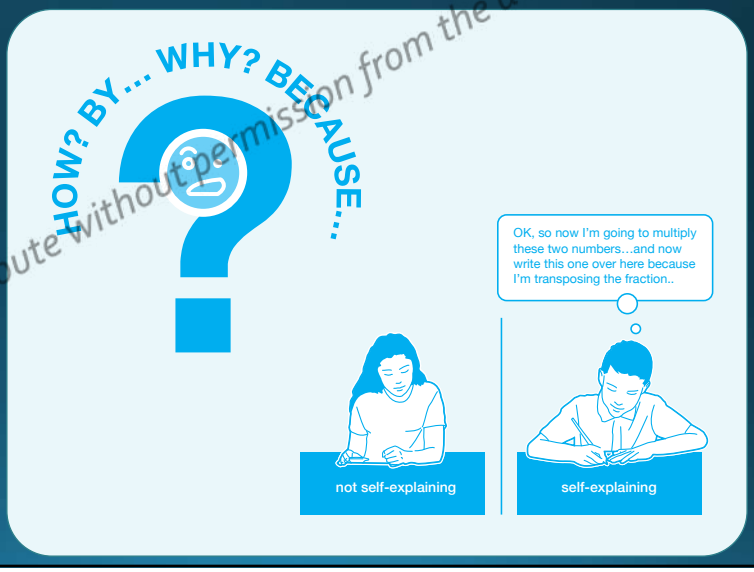
Using Interleaving

- Encourage students to study in little bits, spread out over time, but mix it up!
- Give consistent, cumulative assignments, but mix it up!
- Schedule reviews, but mix it up!

Understand

Elaboration

Main idea: Elaboration

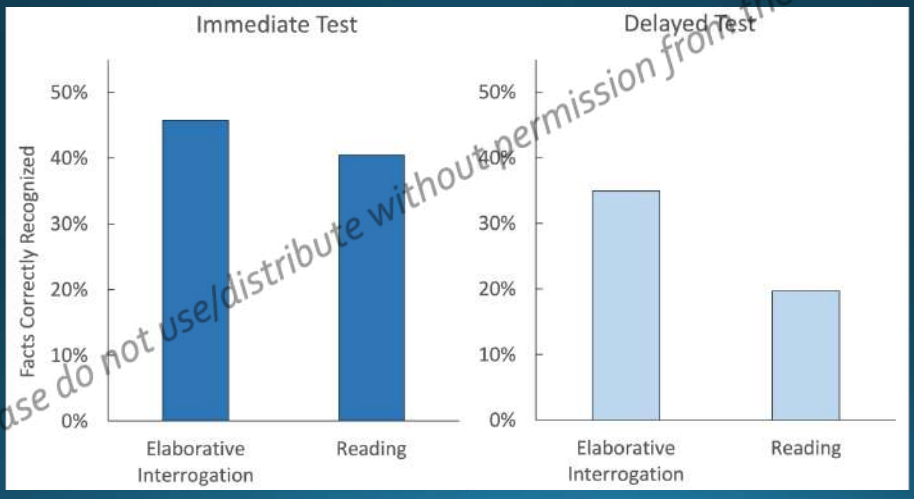


Elaborative interrogation vs. reading

- Learned science facts in pairs or alone
- Three learning strategies implemented:
  - Reading
  - Elaborative interrogation
- Tested immediately or 60 days later

Woloshyn & Stockley (1995)

Elaborative interrogation vs. reading



Woloshyn & Stockley (1995)

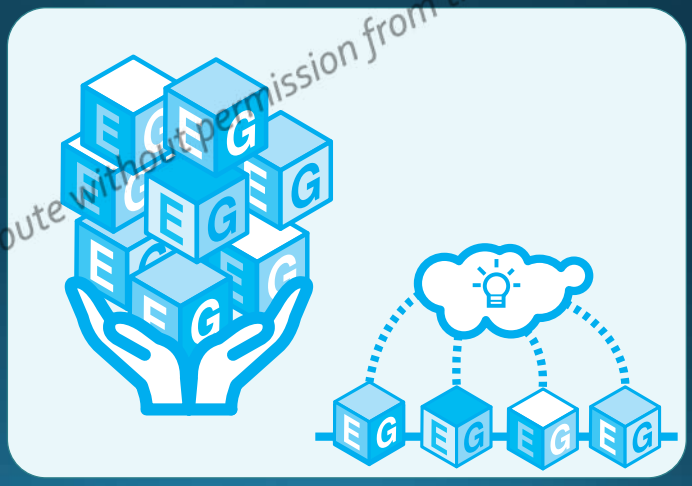
Using Elaboration

- Encourage students to describe and explain in their own words
- Use compare and contrast activities
- Consider implementing in group work

Understand

Concrete Examples

Main idea: Concrete Examples



Use multiple, varied examples

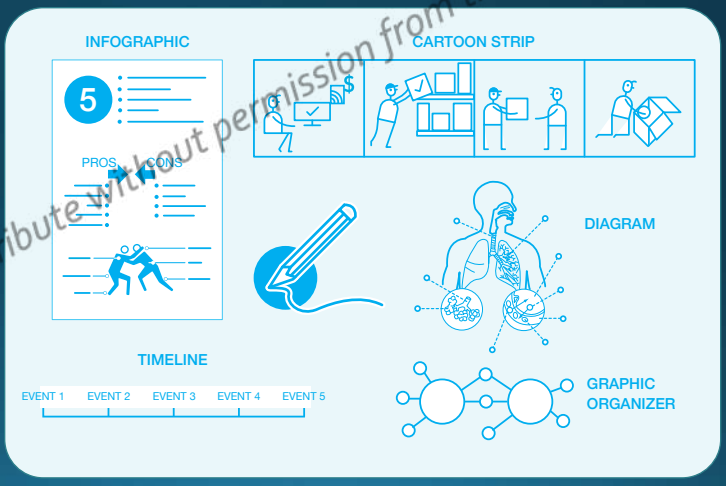
Using Concrete Examples

- Give multiple examples
- Focus on different surface features
- Highlight
  - *What are the underlying principles?*
  - *How are they similar?*
  - *How are they different?*

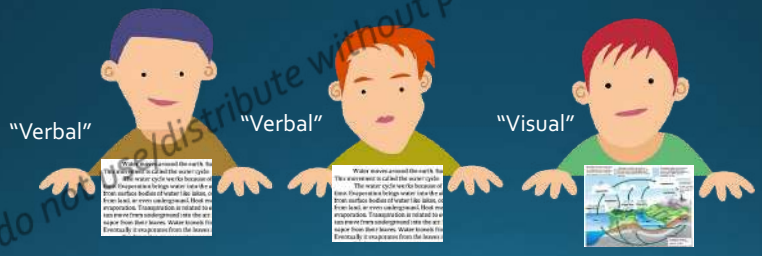
Understand

Dual Coding

Main idea: Dual Coding



Be careful: Learning Styles



Be careful: Dual Coding

Using Dual Coding

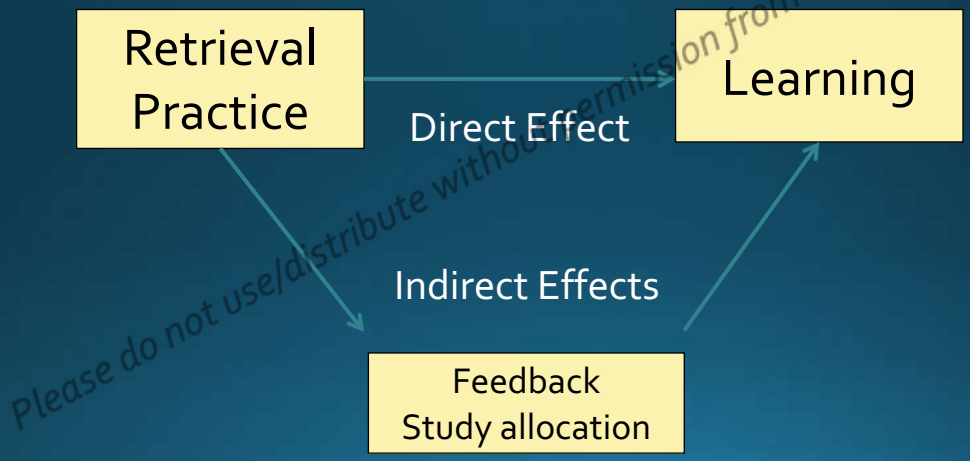
- Give multiple representations of information
- Focus on meaningful images
- Give time to process words and visuals

Reinforce

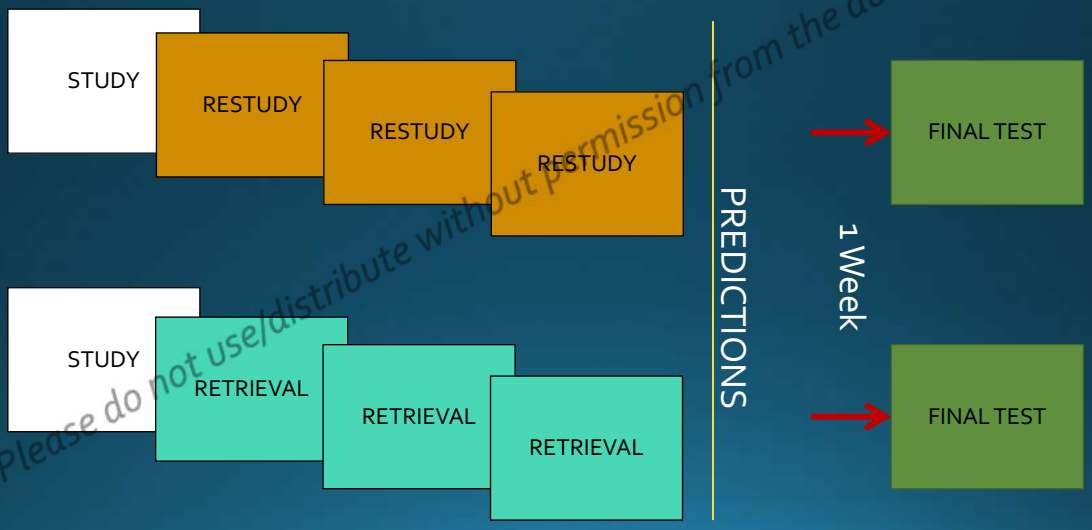
Retrieval Practice

Main idea: Retrieval Practice

Effects on Learning

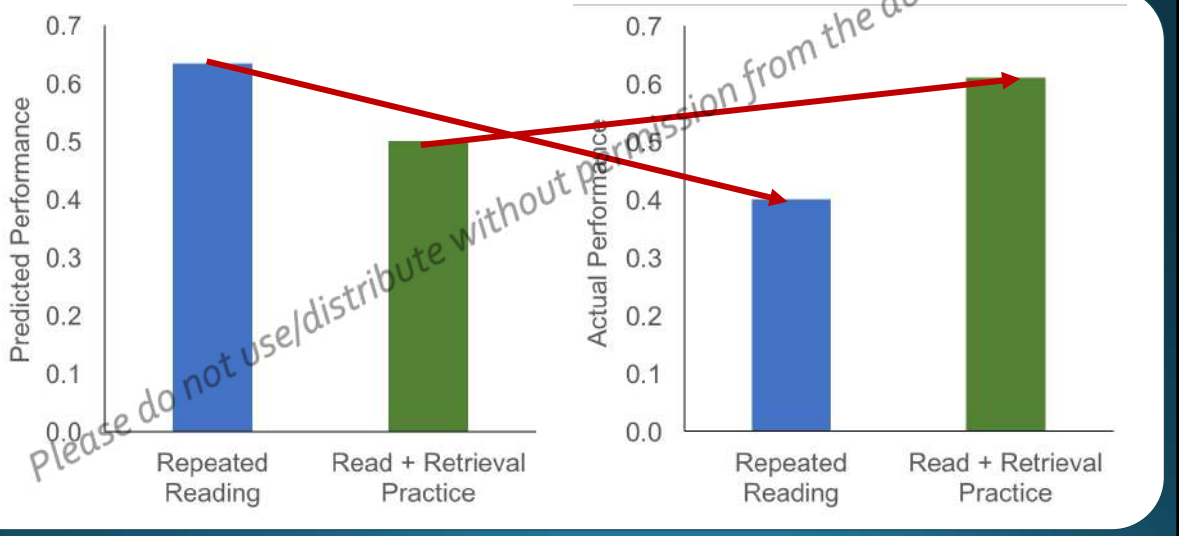


Direct effects of retrieval practice



Roediger & Karpicke (2006, exp 2)

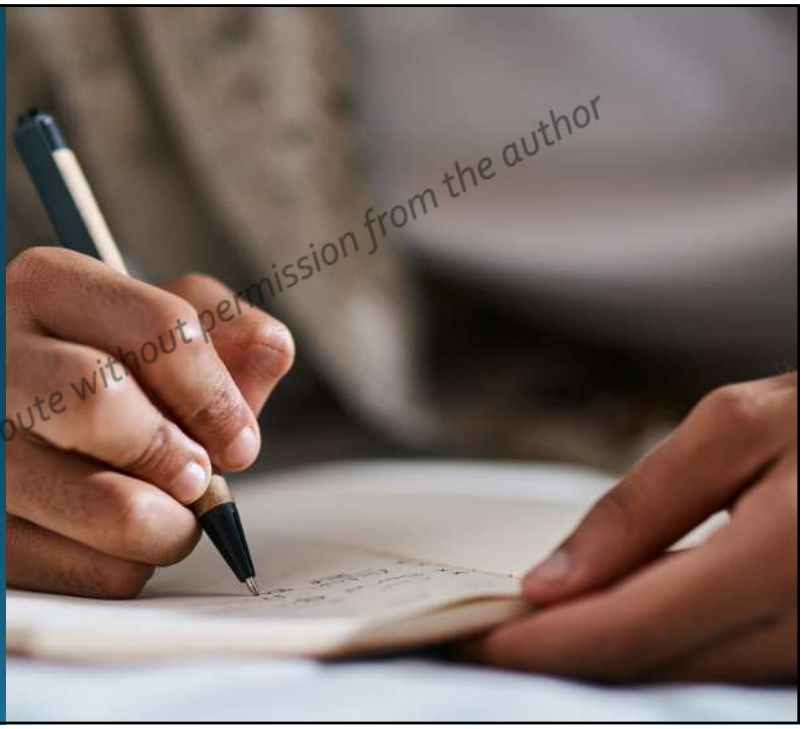
Do learners realize retrieval helps?



Roediger & Karpicke (2006, exp 2)

Using Retrieval Practice

- Encourage students to practice recalling what they know
- Give frequent, no-stakes or low-stakes retrieval opportunities
- Emphasize that it is okay to struggle



Free Resources

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Podcast Episodes for Students

Episode 14 - How Students Can Use Spacing and Retrieval Practice
Mar 7, 2018

Episode 15 - How Students Can Use Interleaving, Elaboration, Dual Coding, and Concrete Examples
Mar 21, 2018

LISTEN ON Spotify

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Books

Thank you and see you this afternoon!

Free resources at learningscientists.org made possible by:

Putting Research Into Practice: Infusing the Science of Learning Into Your Teaching

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August 11, 2025

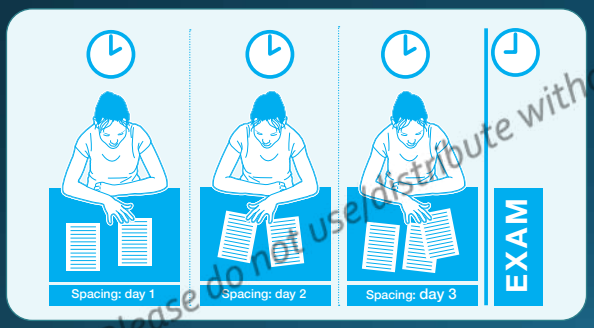
Afternoon Overview

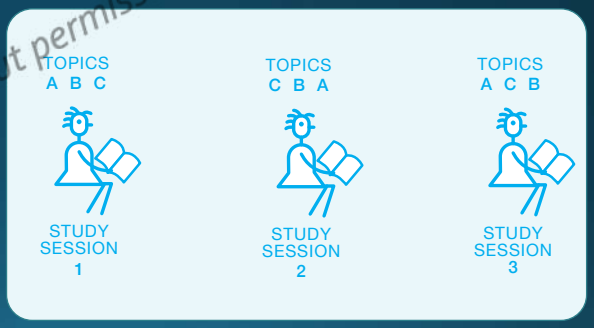
- Plan: Spacing & Interleaving
- Brainstorm
- Understand: Elaboration, Concrete Examples, Dual Coding
- Brainstorm
- Reinforce: Retrieval Practice
- Brainstorm
- Reflect, Plan, Prioritize

Questions

- For quick clarification questions, please stop us and ask!
- For other questions, please use this code to submit prior to the Q&A at the end.

Main ideas:
Spacing & Interleaving

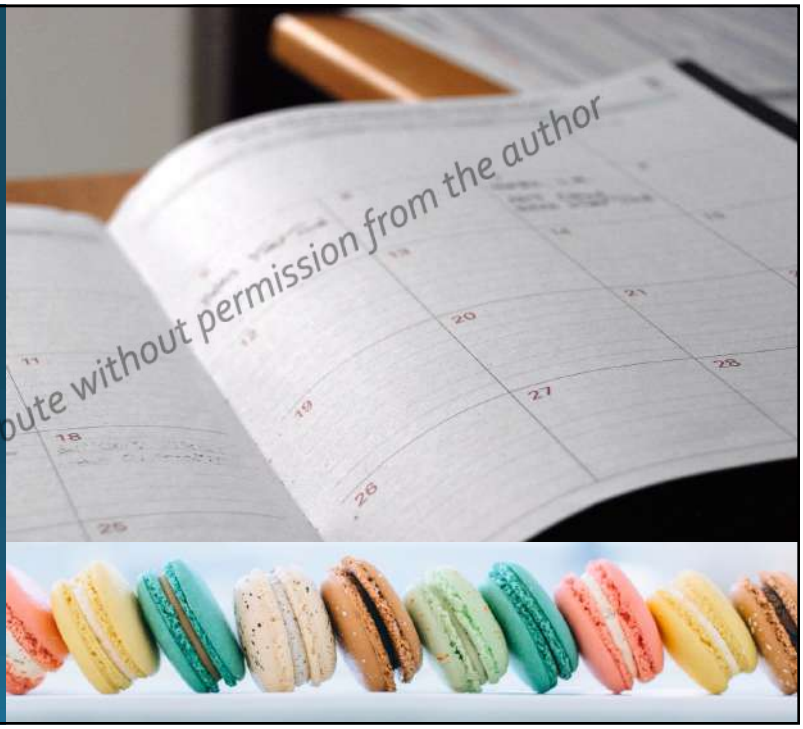




DEMO:
Who remembers the answer from this morning?

Using Spacing & Interleaving

- Encourage students to study in little bits, spread out over time, but mix it up!
- Give consistent, cumulative assignments, but mix it up!
- Schedule reviews, but mix it up!



Spacing Plan

	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
1	Taught	Lag Hwk		SL 1				SL 2		
2		Taught	Lag Hwk		SL 1			SL 2		
3			Taught		Lag Hwk	SL 1			SL 2	
4				Taught		Lag Hwk		SL 1		
5					Taught	Lag Hwk			SL 2	
6						Taught	Lag Hwk		SL 2	
7							Taught		Lag Hwk	
8									Taught	

TOPIC

Inspired by *Mr Benney, Penyrheol Comprehensive School, UK*

Easy way to implement interleaving

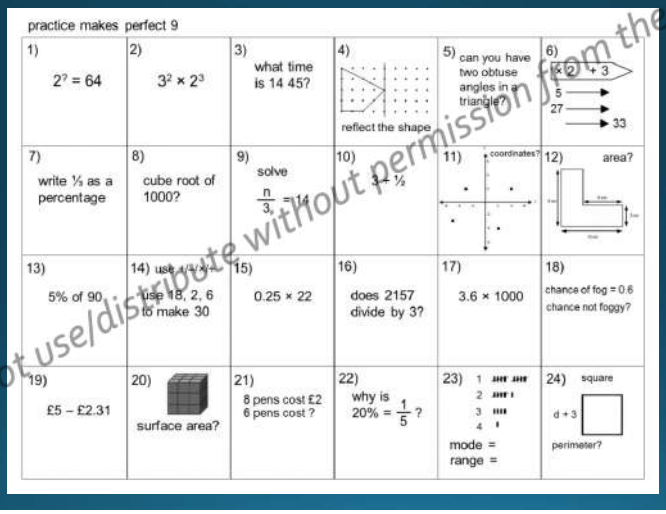


Image from *Steven Shaw, Senior Leader, International School in Hong Kong*

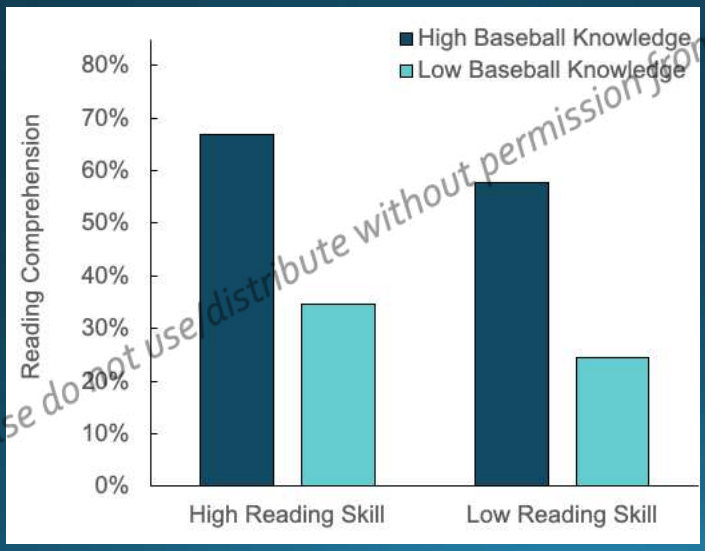
The Importance of Background Knowledge

Background Knowledge Affects Reading Comprehension

High reading skill **High baseball knowledge**	**High reading skill** Low baseball knowledge
Low reading skill **High baseball knowledge**	Low reading skill Low baseball knowledge

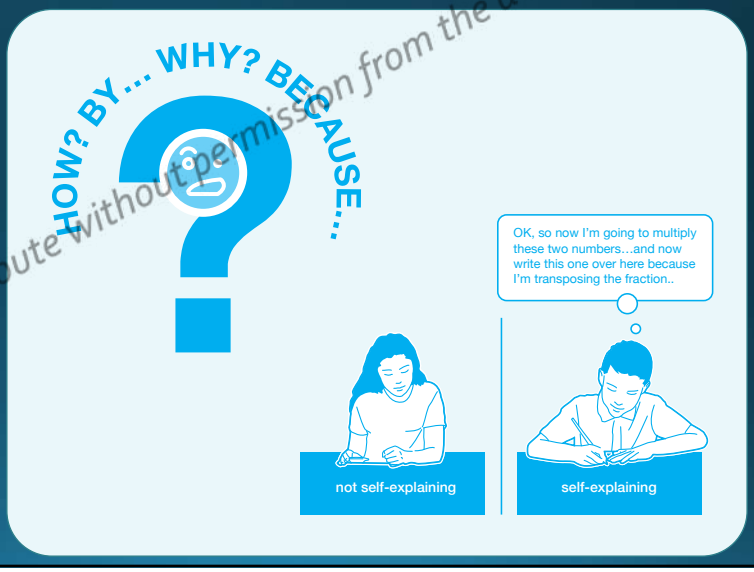
Recht & Leslie (1988)

Background Knowledge Affects Reading Comprehension



Recht & Leslie (1988)

Main idea: Elaboration



Using Elaboration

- Encourage students to describe and explain in their own words
- Use compare and contrast activities
- Consider implementing in group work

Example from physics

Example from nursing

Why did she receive UC diagnosis?

Why did temp spike?

How did patient respond?

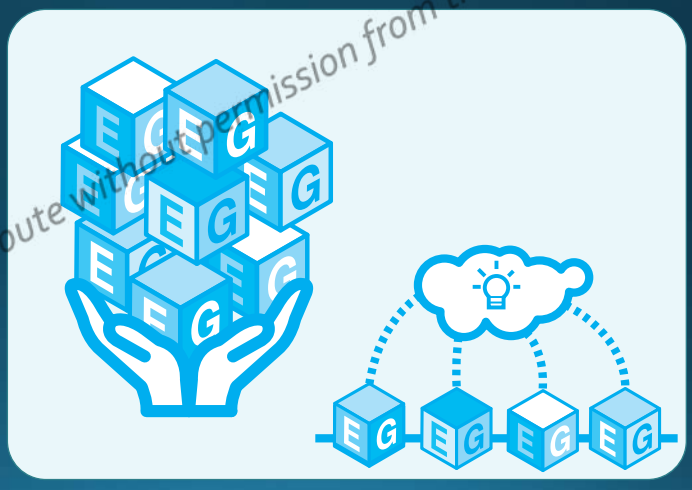
headache and neck stiffness

Major Surgical or Invasive Procedure:
central line placed, arterial line placed

History of Present Illness:
54 year old female with recent diagnosis of ulcerative colitis on 6-mercaptopurine, prednisone 40-60 mg daily, who presents with a new onset of hea patient is in distress, rigoring d history is obtained. She report morning of [**2147-11-16**] with a as bandlike. She states that headaches a photo- or phonophobia. She did ha to the ED p of 96.5, however she l), HR 91, BP 112/54, RR relealved attenuation the right medial frontal pressure 24 cm H20 WBC of given Vancomycin 1 gm IV, Ceftriaxone 2 gm IV, Acyclovir 800 mg IV, Ambesone 183 IV, Ampicillin 2 gm IV q 4, Morphine 2-4 mg Q 4-6, Tylenol 1 gm , Decadron 10 mg IV. The patient was evaluated by Neuro in the ED.
.
Of note, the patient was recently diagnosed with UC and was started on 6MP and a prednisone taper along with steroid enemas for UC treatment. She was on Bactrim in past but stopped taking it for unclear reasons and unclear how long ago.
.

Past Medical History:
chronic back pain, MRI negative
osteopenia - fosamax d/c by PcP
leg pain/parasthesias

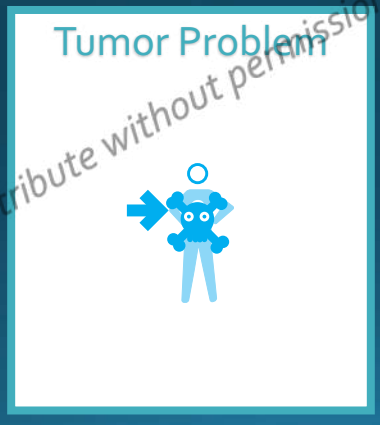
Main idea: Concrete Examples



Transfer of knowledge is very difficult

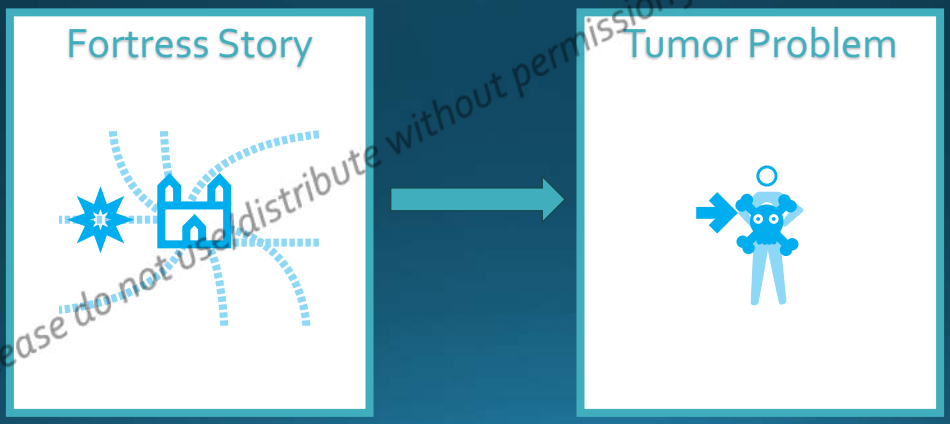
Gick & Holyoak (1988; 1983)

Transfer of knowledge is very difficult



Gick & Holyoak (1988; 1983)

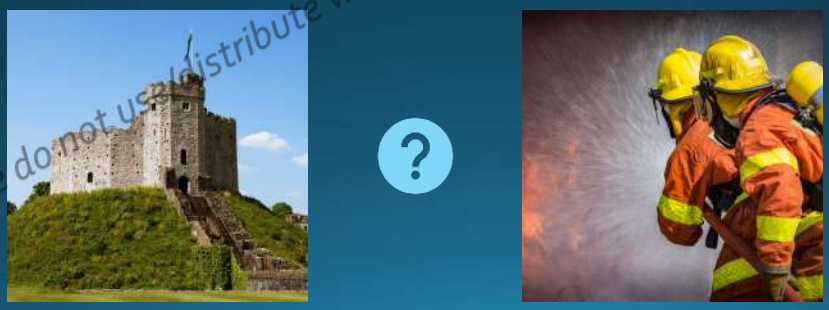
Transfer of knowledge is very difficult



Gick & Holyoak (1988; 1983)

Use multiple, varied examples

- Have learners determine links between examples



Using Concrete Examples

- Give multiple examples
- Focus on different surface features
- Highlight
  - *What are the underlying principles?*
  - *How are they similar?*
  - *How are they different?*

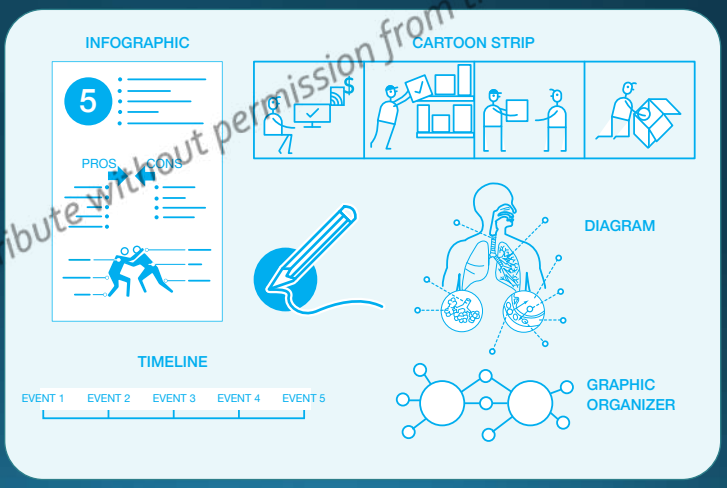
Example from Psychology

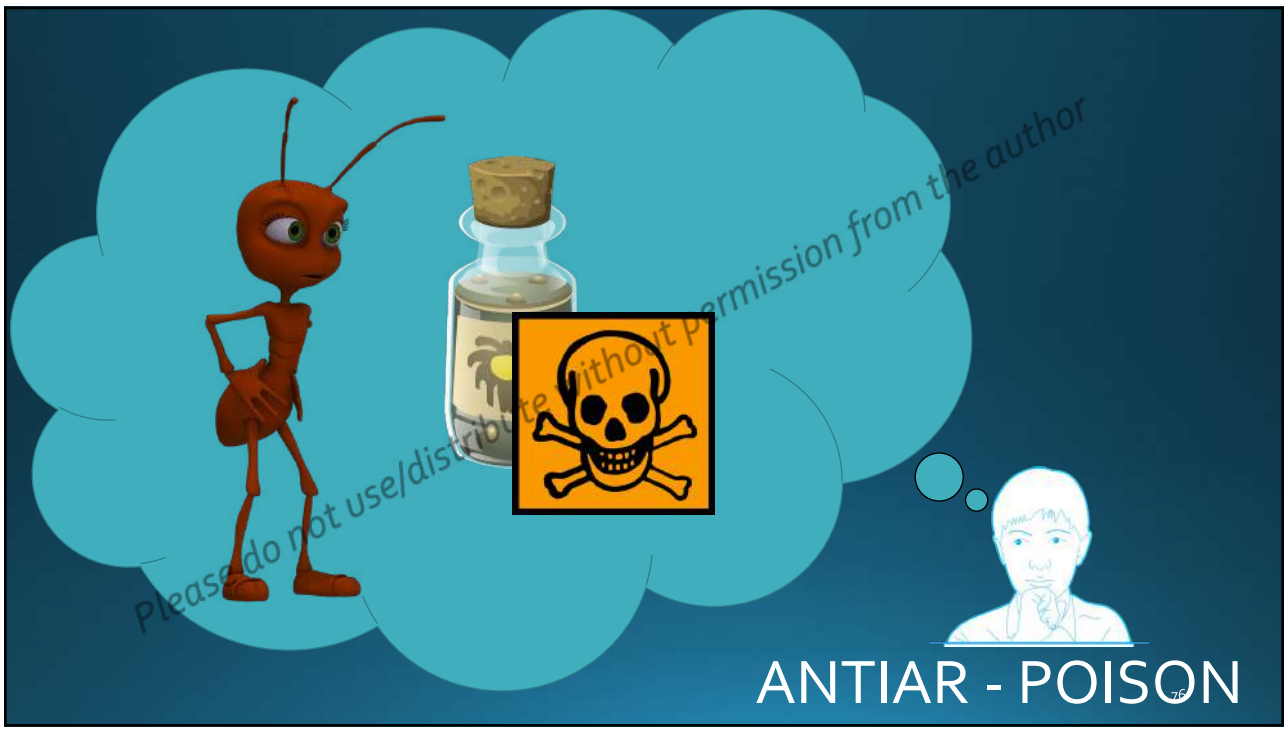
- Behavior modification
  - Multiple examples of punishment *and* reinforcement
  - Include positive and negative examples of both
  - Compare and contrast operant and classical conditioning

Example from Finance

- Different types of loans
  - Mortgage
  - Personal unsecured
  - Commercial
  - Small business lending

Main idea: Dual Coding

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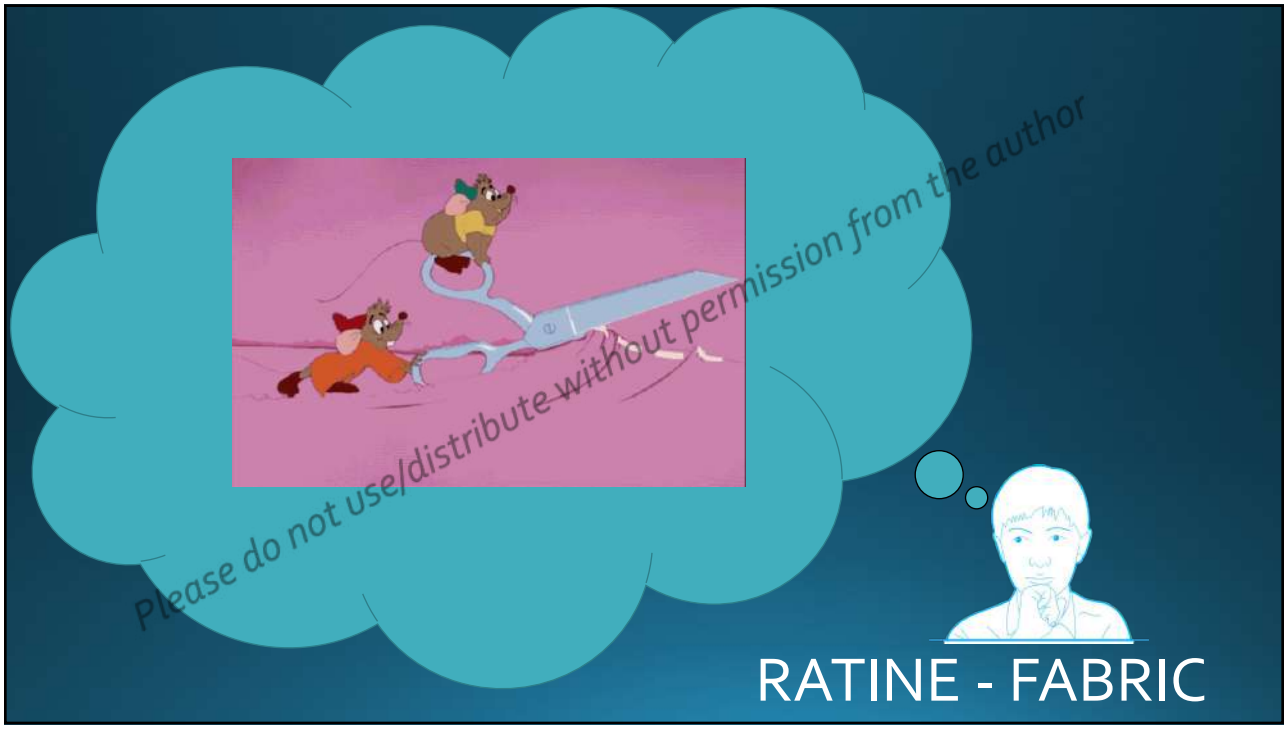
ANTIAR - POISON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RATINE - FABRIC

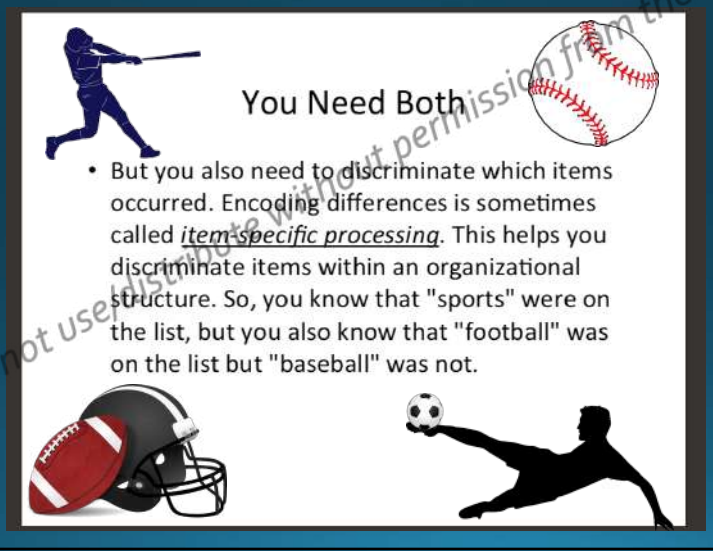

GRAMPUS - DOLPHIN


LOGGIA - BALCONY

Using Dual Coding

- Give multiple representations of information
- Focus on meaningful images
- Give time to process words and visuals

So, do I just insert pictures?



Be mindful of overload

Brainstorm

Brainstorm ideas for implementation

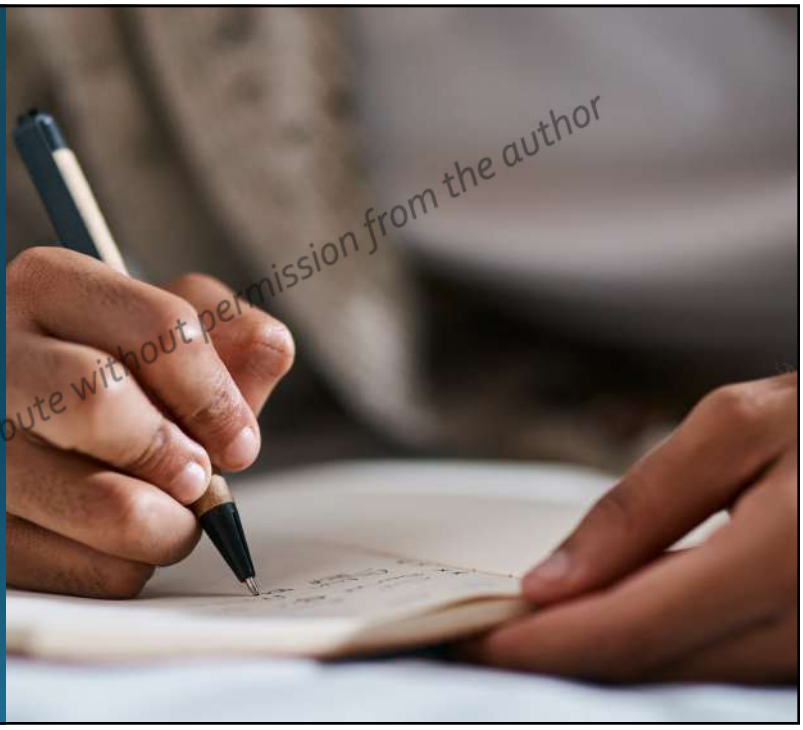
Elaboration, concrete examples, and/or dual coding

Main idea:
Retrieval Practice

- ANTIAR - ?
- LOGGIA - ?
- RATINE - ?
- GRAMPUS - ?

Using Retrieval Practice

- Encourage students to practice recalling what they know
- Give frequent, no-stakes or low-stakes retrieval opportunities
- Emphasize that it is okay to struggle



Using retrieval practice

Spaced retrieval practice

Quiz construction:

Q1 – Q3 – retrieval of information from last class
Q4 – retrieval of information from last week
Q5 – retrieval of information from last month
Q6 – make link between information from last class & previously learned information

Example based on blog by *MrTharby, UK Author and teacher*

Reflection

- *Page 8 of packet*

- Of all of your ideas today, what do you *actually want to do*?
  - Things I can do right away?
  - Things I can can plan for longer term?
  - What is your **top priority**?

Any questions? Use the QR Code