


Generative Learning Strategies to Generate Productive Learning

Em. Prof. dr. Paul A. Kirschner

Open Universiteit / Thomas More Hogeschool / kirschner-ED

kirschner^{ED}

research  **ED**

@P_A_Kirschner

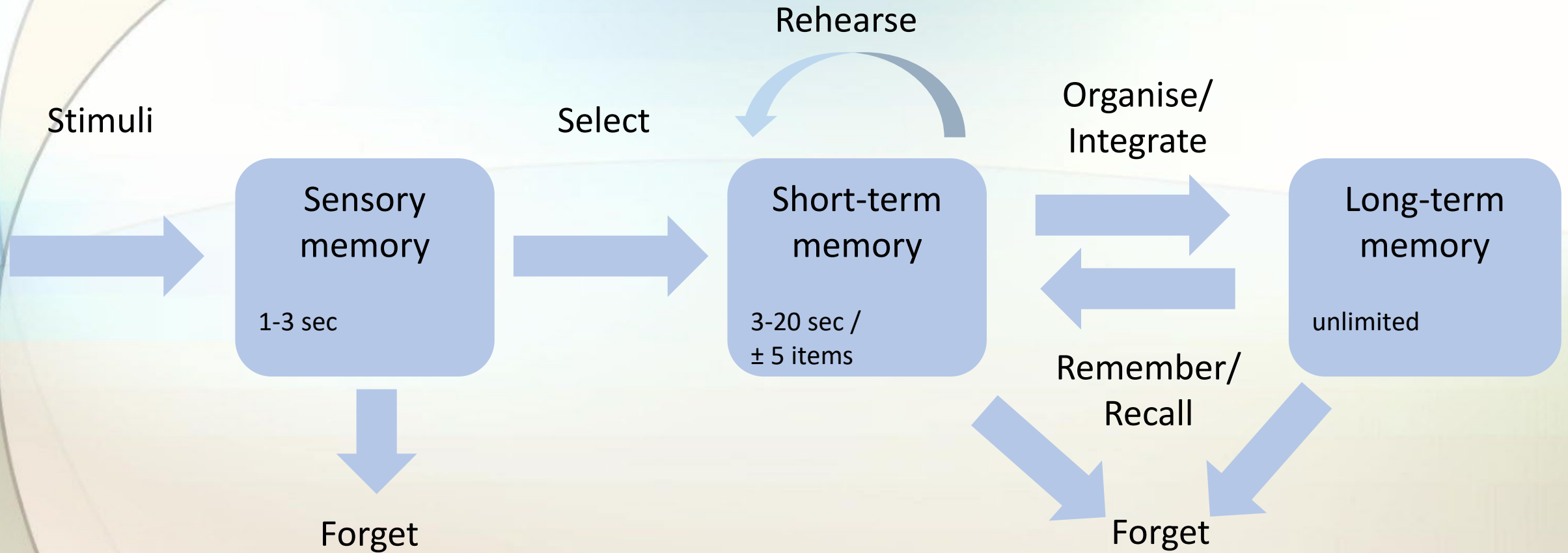
Topics

- What's learning?
- What's generative learning?
- Some generative learning strategies for productive learning
- How can students acquire generative learning strategies?

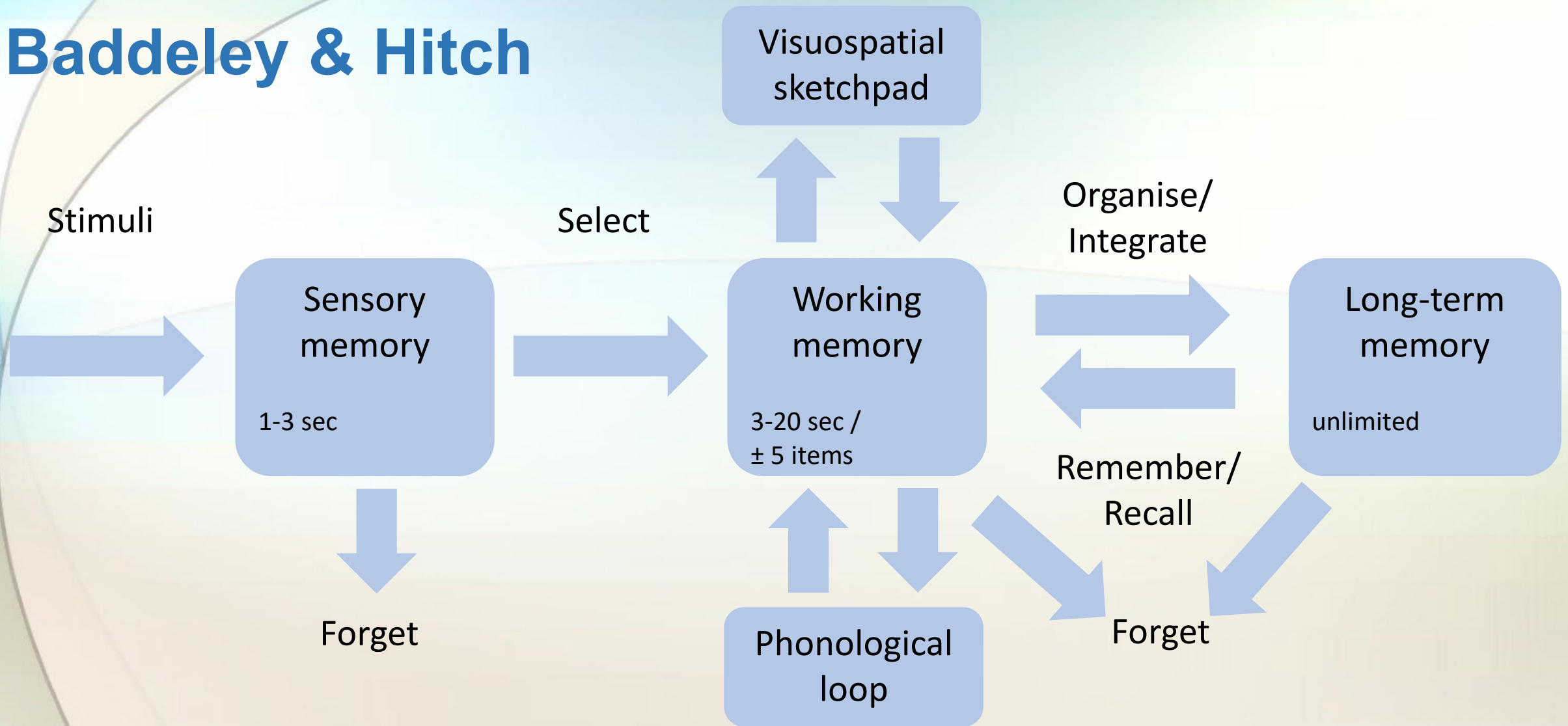
Learning

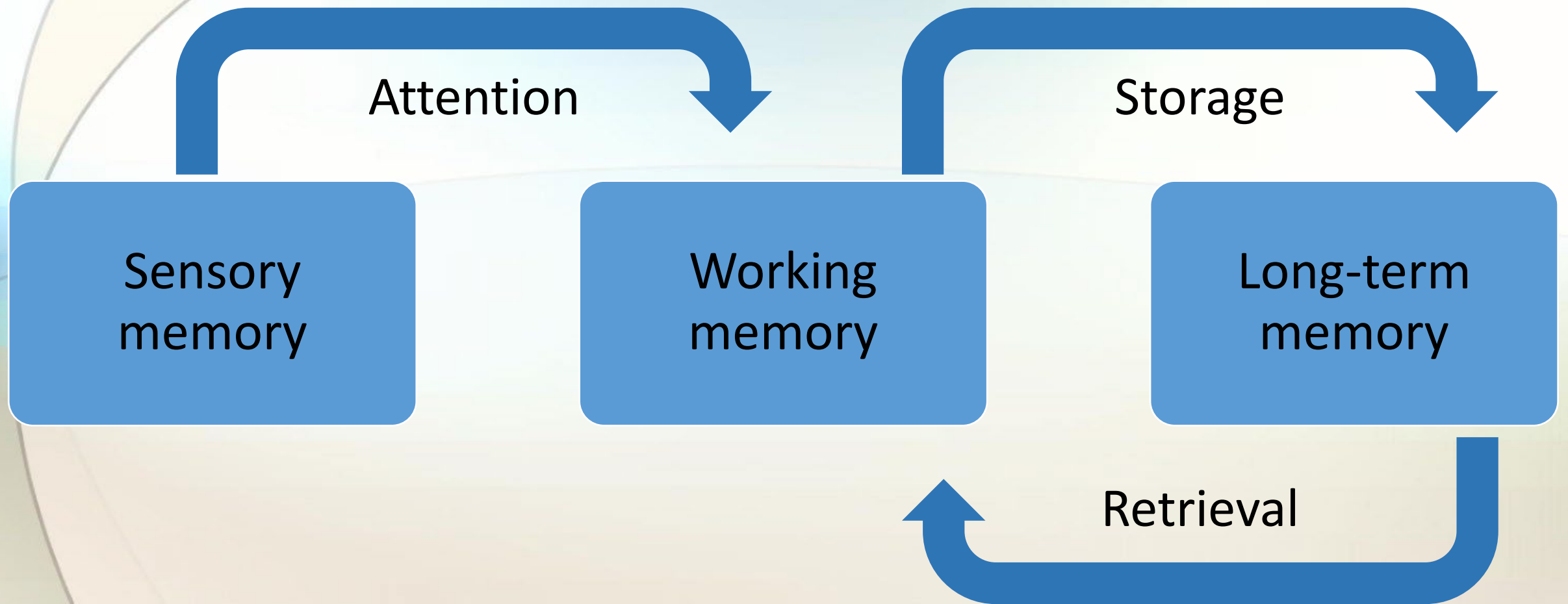
- Change in **longterm memory**
- **Stable**
- Result of **cognitive processing** of information
- First **create** a network of neurons, then **(re)activate** that network

Atkinson & Shiffrin



Baddeley & Hitch



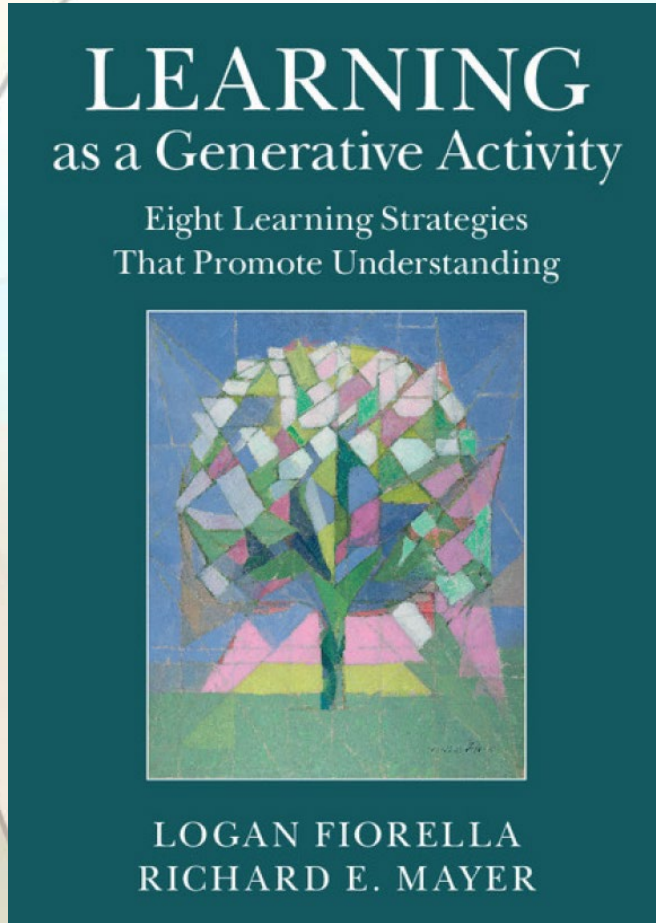


Processing: Storage + Retrieval

- No processing = No learning
- Shallow processing = Shallow learning
- Deep processing = Deep learning
- More and more different processing = Better learning & retention

$$\sum_1^n Store + \sum_1^n Retrieve = \sum Learn/Retain$$

What is generative learning?



Generative learning:

- Active and generative
- Gives meaning to content (Wittrock, 1974)
- Couples new information to prior knowledge and reworks it into a new product (Fiorella & Mayer, 2015)

Learning as a Generative Activity

- Learning is **sense-making**

“...the mind...is not a passive consumer of information, ...it actively constructs its own interpretations of information and draws inferences on them.” (Wittrock, 1989)

- Improve learning via:

- instruction
- learning/study strategies
- Cognitively active processing

What is generative learning?

Activities that prompt learners to produce something meaningful that **goes beyond** the information provided by an instructor.

In doing so, learners have to **activate prior knowledge** and **link it to the provided information**, which is assumed to foster integration of new information into existing knowledge structures.

Brod, G. (2020). Generative learning: Which strategies for what age? *Educational Psychology Review*. Advance online publication. <https://doi.org/10.1007/s10648-020-09571-9>

Generative Learning Strategies

Require students to make sense of new information by **selecting** important information, **reorganising** and **integrating** the newly acquired information with what is already known.

What isn't generative learning?

Semantics is important! It's not:

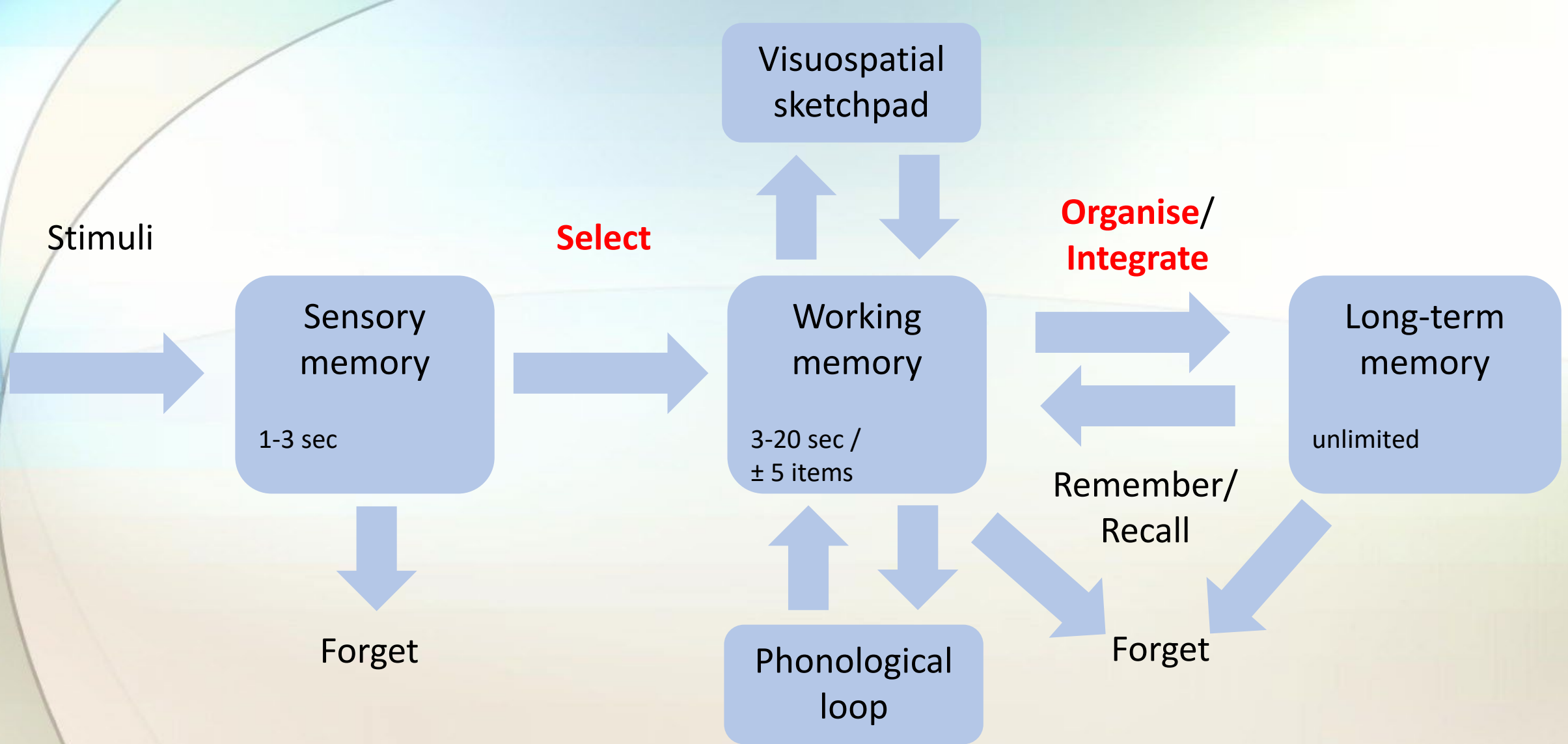
- (Cognitively) Active learning and/or (Motorically) active learning
- Activating learning and/or activating pedagogies

Just because they're engaged, it doesn't mean they're learning

CARL HENDRICK
WELLINGTON COLLEGE, UK; AUTHOR

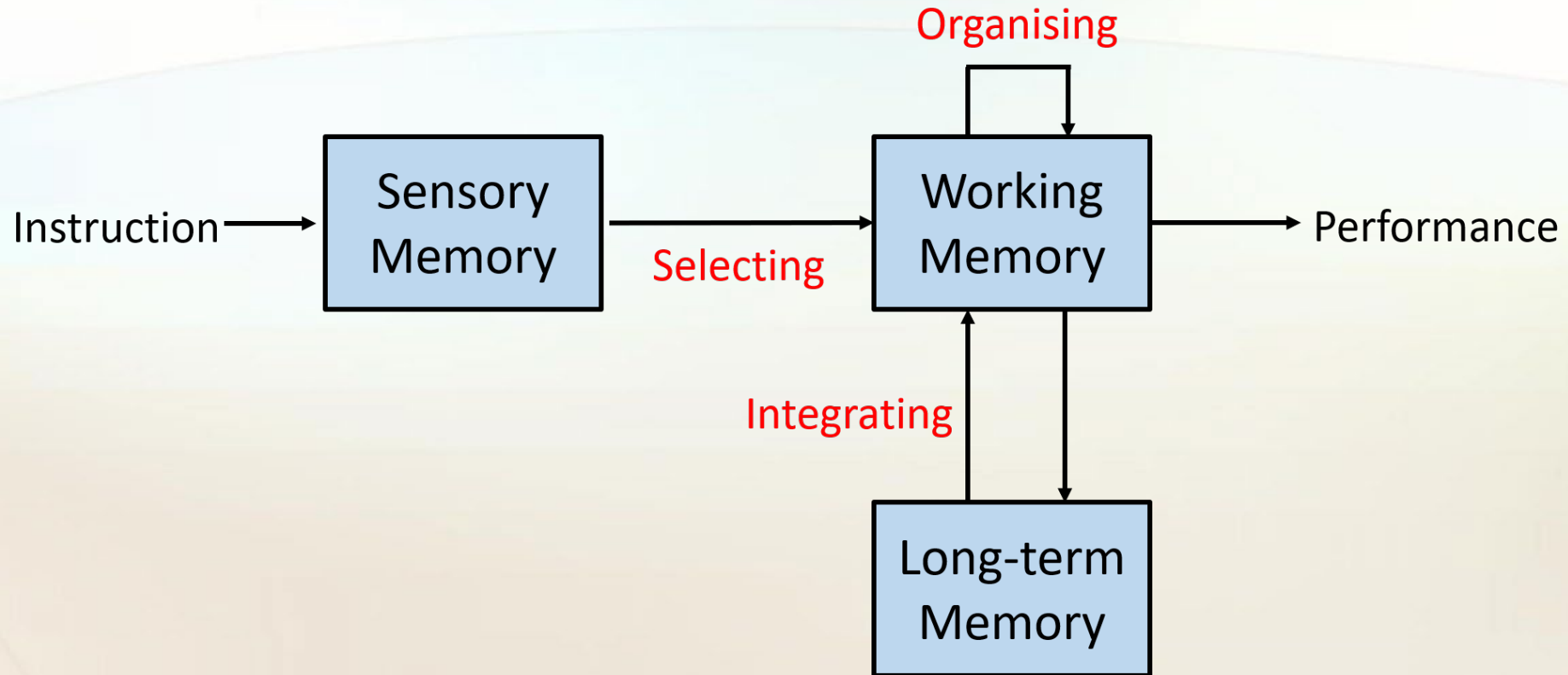
JIM HEAL
DEANS FOR IMPACT, USA



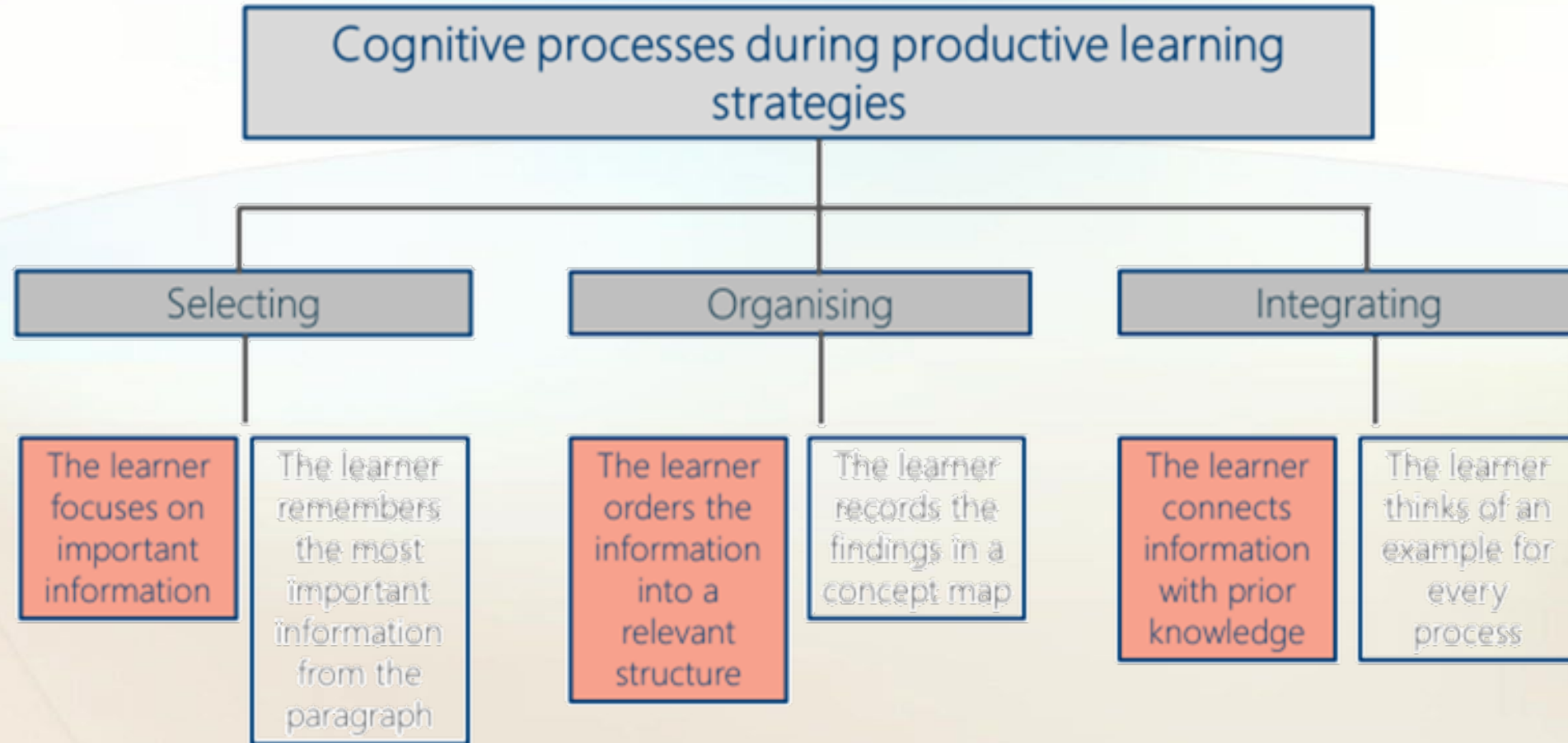


Basis of generative learning

The SOI-model of generative learning (Mayer & Fiorella, 2015)



Processes in generative learning



Approaches to generative learning?

Two approaches to improve learning (based on Mayer & Fiorella, 2015, p.12)

Approach	Description	Focus
Instructional strategy	Facilitate optimal cognitive processing (selecting, organising, integration)	Improve your instruction

Approaches to generative learning?

Two approaches to improve learning (based on Mayer & Fiorella, 2015, p.12)

Approach	Description	Focus
Instructional strategy	Facilitate optimal cognitive processing (selecting, organising, integration)	Improve your instruction
Learning and study strategy	Teach students how to/when to use which strategies to facilitate optimal cognitive processing (selecting, organising, integration)	Improve independent learning/studying (role for both teacher and student)

Some generative learning strategies

Lerarning by...	You...	Brod	M&F
summarising	make a written or oral summary of the content in your own words		X
mapping	make a spatial representation with core concepts (mindmap/concept map)	X	X
drawing	make a drawing of the core concepts/ideas	X	X
imagining	create a mentaal image of the core concepts		X
self-testing	make a written or oral quiz	X	X
self-explaining	explain - either written or oral - the content to yourself	X	X
teaching	teach someone else about the topicc		X
enacting	make task-relevant movements (e.g., gestitulating/manipulating objects		X
thinking up questions	think up questions for yourself	X	
predicting	think up predictions/hypothees about the coontent	X	

Some generative learning strategies

Table 1 Evidence on the effectiveness of generative learning strategies in different age groups

	University students	Secondary-school students	Fourth/fifth-grade students	Below fourth-grade students
Concept mapping	Favorable	Favorable	Favorable	Insufficient
Explaining	Favorable	Favorable	Mixed	Mixed
Predicting	Favorable	Favorable	Favorable	Favorable
Questioning	Favorable	Mixed	Mixed	Unfavorable
Testing	Favorable	Favorable	Favorable	Favorable
Drawing	Favorable	Favorable	Unfavorable	Unfavorable

Brod, G. Generative Learning: Which Strategies for What Age?. *Educ Psychol Rev* **33**, 1295–1318 (2021). <https://doi.org/10.1007/s10648-020-09571-9>

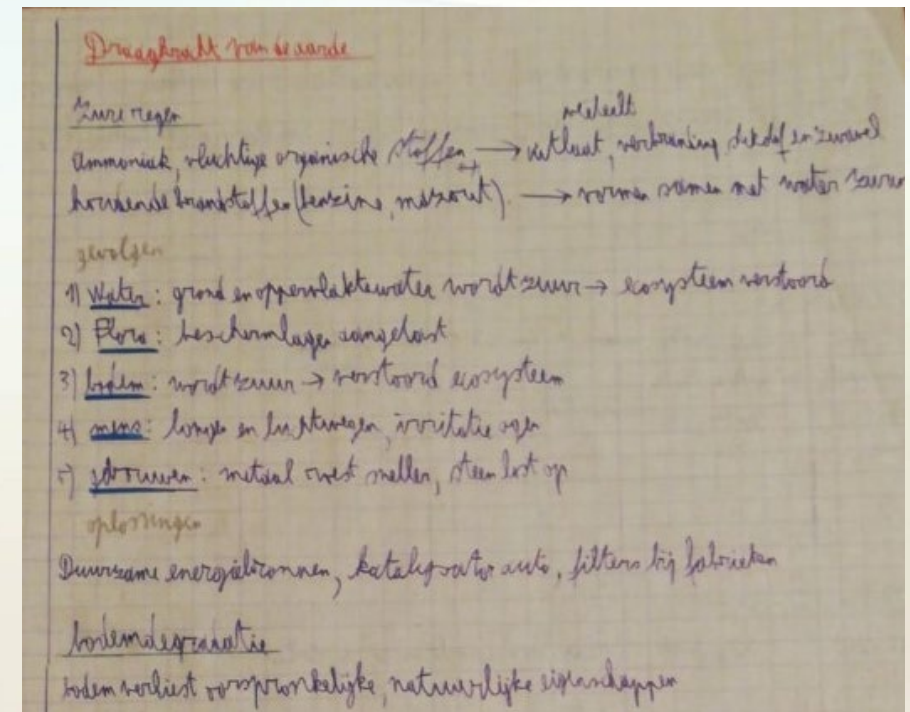
Fiorella & Mayer

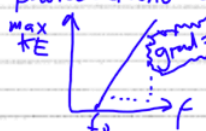
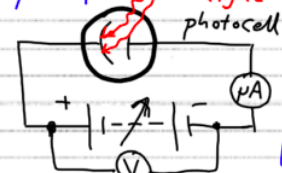
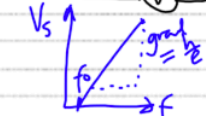
- Summarise – main points (short) in own words
- Map – written/spoken text in a spatial representation
- Draw – visual representation of the contents
- Imagine – mental image of the contents
- Self-test - retrieval-based learning
- Self-explain – explain the content to yourself
- Teach – explain to a (fictitious) other
- Enact – task-relevant movements

Fiorella, L., & Mayer, R. E. (2015). *Learning as a generative activity: Eight learning strategies that promote understanding*. Cambridge University Press.

Summarising

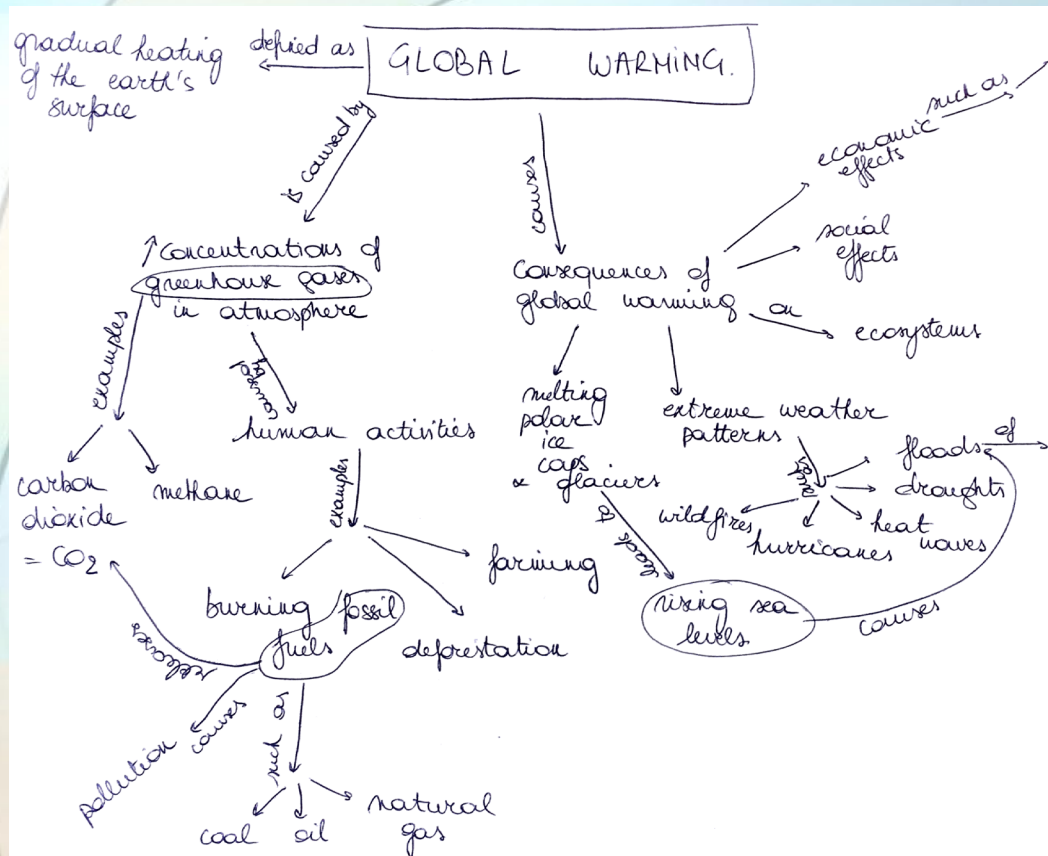
Distilling the most important information from a source and reformulating it in one's own words



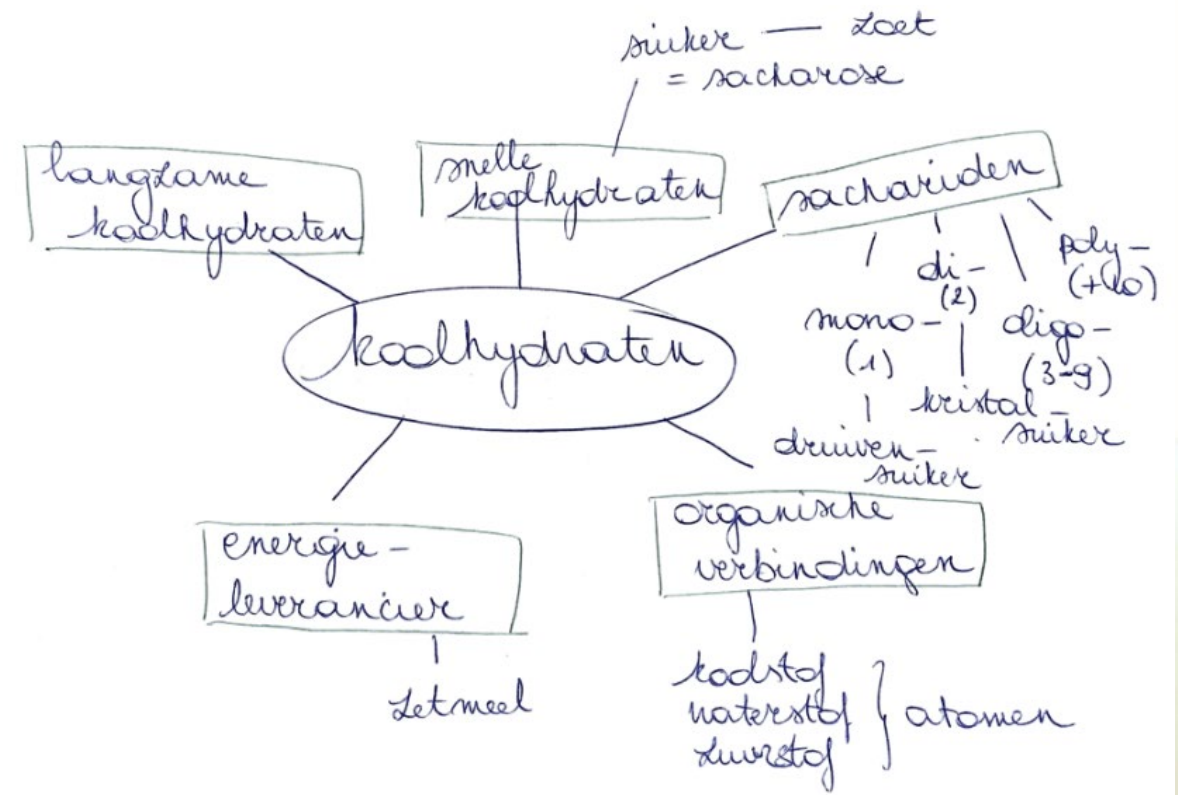
Topic:	PHOTOELECTRIC EFFECT	Name:	
Specification Point:	3.2.2.1	Date:	
Main question:	What is the photoelectric effect and how does Einstein's photoelectric equation define it.		
Questions / Key words	Notes / Definitions / Diagrams / Answers		
What are photoelectrons?	Electrons (called photoelectrons) are emitted from the surface of a metal when bright light is incident on the metal.		
Relationship between intensity and no. of photoelectrons	The higher the *intensity* of the light then the greater the number of photoelectrons emitted. * $I = P/A \Rightarrow W m^{-2}$		
How frequency affects max KE	The frequency of the incident light affects the maximum KE of the photoelectrons. There is a <u>threshold frequency</u> below which no photoelectrons are emitted.		
Graph of $E_{k(max)}$ against frequency.	 $E_{k,max} = hf - \phi$ ϕ is the threshold frequency $h = 6.63 \times 10^{-34} Js$ NOTE: $\phi = hf_0$ Einstein's Photoelectric Eqn.		
Work function and threshold frequency.	Work function is the minimum energy needed for a photoelectron to escape the surface. NOTE: 1 photon interacts with 1 electron so $\phi = hf_0$ $\lambda = \frac{c}{f}$		
Evidence that e-m radiation consists of particles.	 The stopping potential is the PD which just stops the photoelectrons so the μA read zero. $E_{k,max} = V_s \times e$ $eV_s = hf - \phi$ $V_s = \frac{hf}{e} - \frac{\phi}{e}$ $y = mx + c$		
Photocell circuit and stopping potential V_s .			
Graph of stopping potential against frequency.			
Summary	The PE effect is when photoelectrons are emitted from the surface of a metal when light with a frequency greater than the threshold frequency is incident upon it. ② $E_{k(max)}$ is equal to the energy of the photon (hf) minus the work function (ϕ). It does not predict the number of photoelectrons emitted; that depends on the intensity of the light.		

Mapping

Distilling the most important concepts from an information source and organising them so that the (inter)relationships are visually clear via graphical connections, often lines or arrows



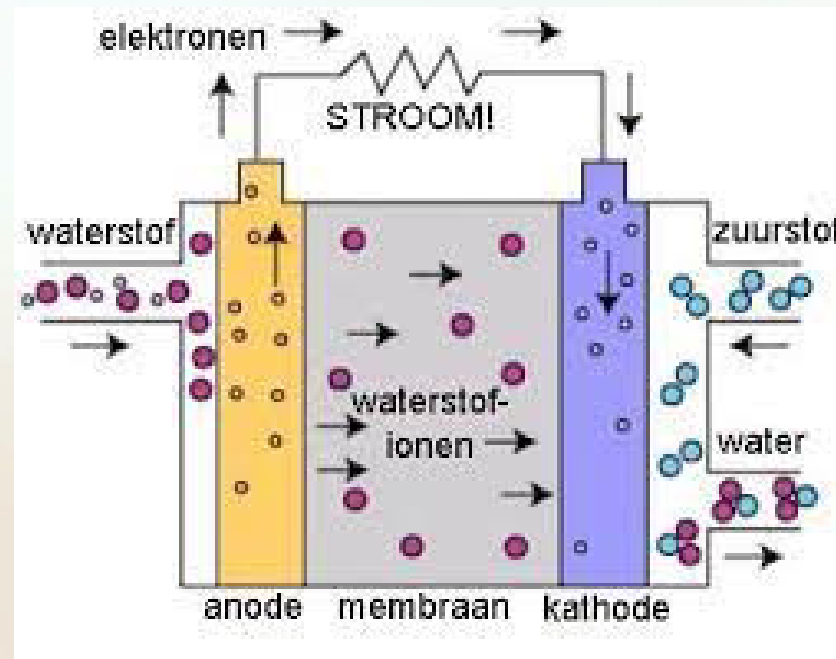
Concept map

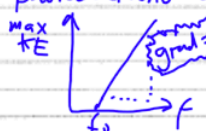
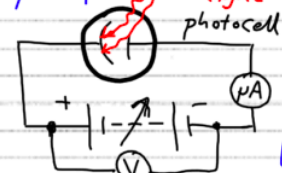
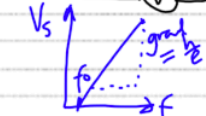


Mind map

Drawing

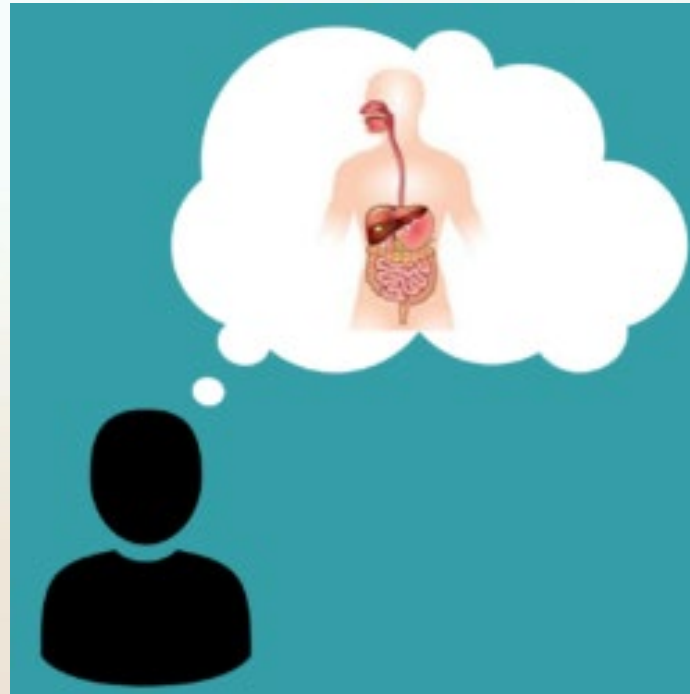
Converting textual material (verbal information) into the form of a drawing (visual information)



Topic:	PHOTOELECTRIC EFFECT	Name:	
Specification Point:	3.2.2.1	Date:	
Main question:	What is the photoelectric effect and how does Einstein's photoelectric equation define it.		
Questions / Key words	Notes / Definitions / Diagrams / Answers		
What are photoelectrons?	Electrons (called photoelectrons) are emitted from the surface of a metal when bright light is incident on the metal.		
Relationship between intensity and no. of photoelectrons	The higher the *intensity* of the light then the greater the number of photoelectrons emitted. * $I = P/A \Rightarrow W m^{-2}$		
How frequency affects max KE	The frequency of the incident light affects the maximum KE of the photoelectrons. There is a threshold frequency below which no photoelectrons are emitted.		
Graph of $E_{k(max)}$ against frequency.	 $E_{k,max} = hf - \phi$ ϕ is the threshold frequency h is Planck's constant $= 6.63 \times 10^{-34} Js$		
Work function and threshold frequency.	<p>NOTE: $\phi = hf_0$</p> <p>Work function is the minimum energy needed for a photoelectron to escape the surface.</p> <p>NOTE: 1 photon interacts with 1 electron so $\phi = hf_0$</p> <p>$\lambda = \frac{c}{f}$</p> <p>Einstein's Photoelectric Eqn.</p>		
Evidence that e-m radiation consists of particles.	 <p>The stopping potential is the PD which just stops the photoelectrons so the μA read zero.</p> <p>$E_{k,max} = V_s \times e$ $eV_s = hf - \phi$ $V_s = \frac{hf}{e} - \frac{\phi}{e}$ $y = mx + c$</p>		
Photocell circuit and stopping potential V_s .			
Graph of stopping potential against frequency.			
Summary	<p>The PE effect is when photoelectrons are emitted from the surface of a metal when light with a frequency greater than the threshold frequency is incident upon it.</p> <p>$E_{k(max)}$ is equal to the energy of the photon (hf) minus the work function (ϕ). It does not predict the number of photoelectrons emitted; that depends on the intensity of the light.</p>		

Imagining

Consciously forming a mental image of the information read or listened to



Self-testing

Trying to recall something one has learnt (i.e., from long-term memory) by testing oneself about it

Side one

Side two

To be able to

Pouvoir

To have to/
to owe

Devoir

To want

Vouloir

Retrieval Practice Placemat ...

What keywords did you use or learn last lesson?

Explain a key concept or idea from last week in your own words.

State 3 key facts from last lesson.

Ask your partner 3 questions based on the content covered this term.

No notes allowed!

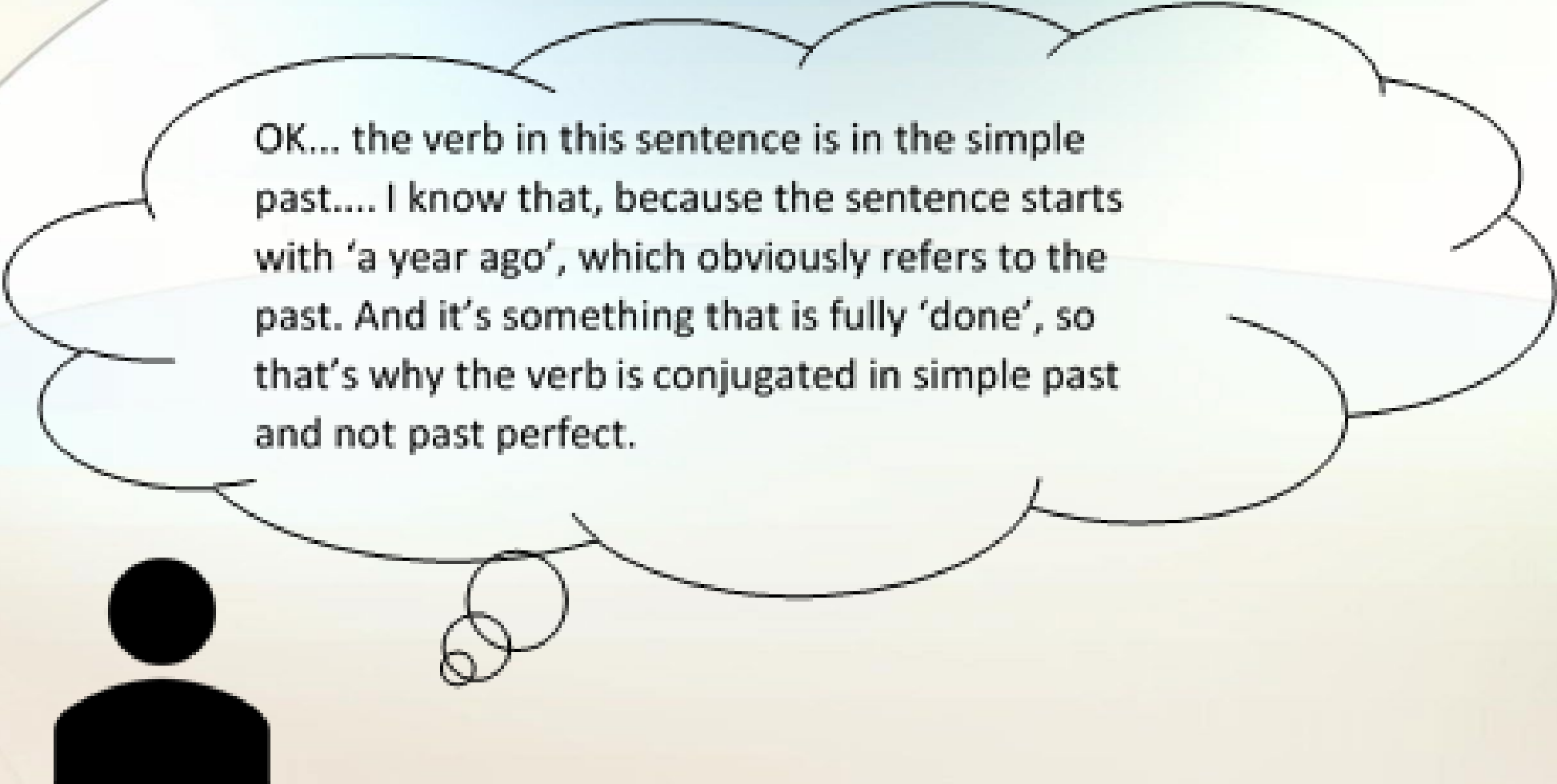
Discuss with your partner what we were studying in the lesson last week.

Insert question from further back	Insert question based on content from last week	Insert question based on content from two weeks ago
Insert question based on content from two weeks ago	Insert question from further back	Insert question based on content from last week
Insert question based on content from last lesson	Insert question based on content from two weeks ago	Insert question from further back
Insert question from further back	Insert question based on content from last week	Insert question based on content from last lesson

One Point - Last lesson	Two Points - Last week	Three Points - Two weeks ago	Four Points - Further back
-------------------------	------------------------	------------------------------	----------------------------

Self-explaining

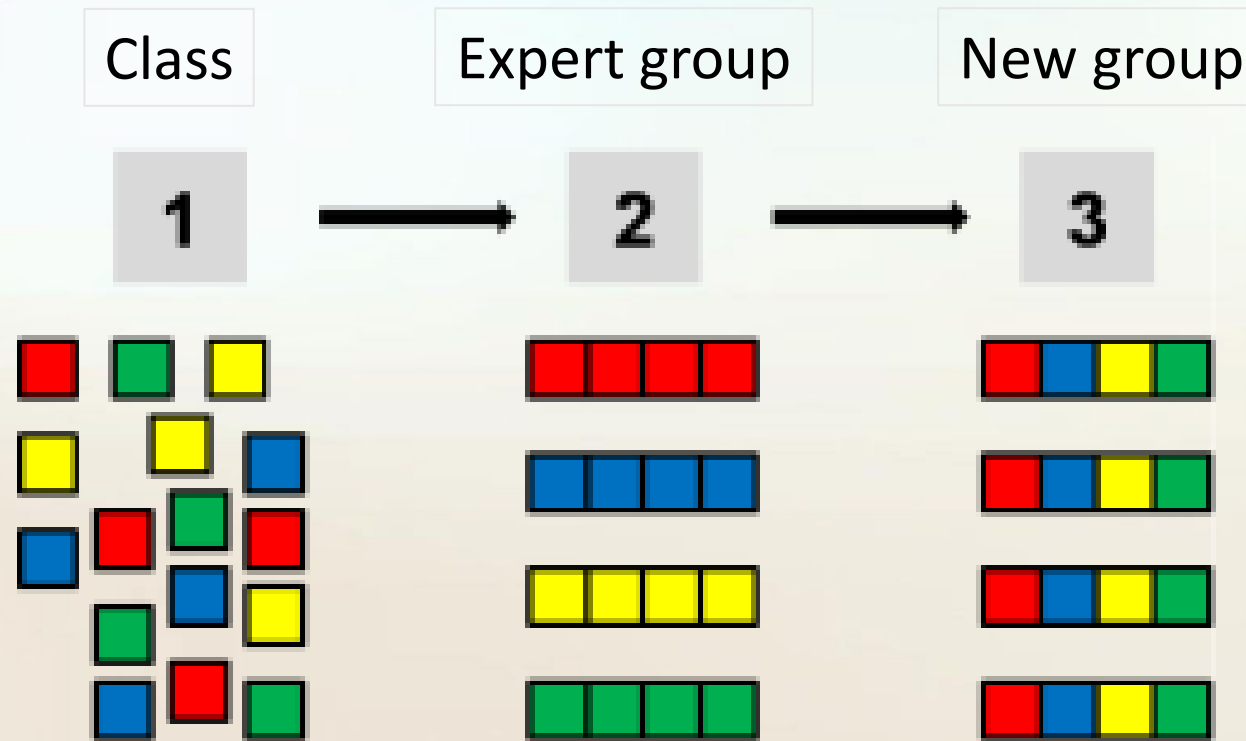
Generating explanations (i.e. explaining something) during learning so that relevant prior knowledge is activated and integrating and organising the new information becomes easier.



OK... the verb in this sentence is in the simple past.... I know that, because the sentence starts with 'a year ago', which obviously refers to the past. And it's something that is fully 'done', so that's why the verb is conjugated in simple past and not past perfect.

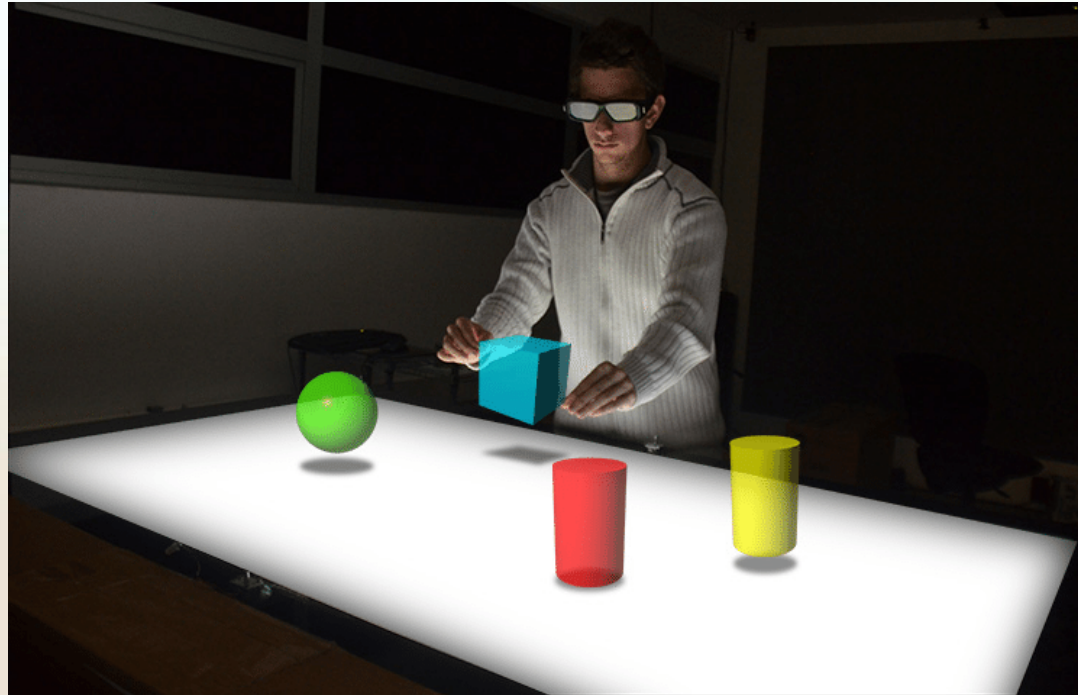
Teaching

Explaining the subject matter studied to someone else (real or fictional)

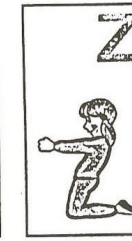
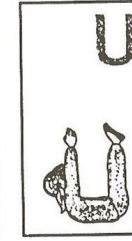
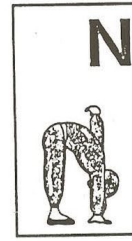
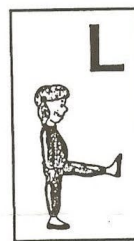
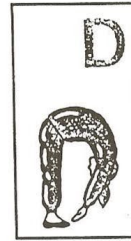
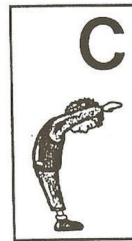


Enacting

Manipulating objects or performing task-relevant movements or gestures related to what one is trying to learn



HET LICHAAMSALFABET is een leuke, nieuwe en dynamische manier om met elkaar te spreken. Je doet het namelijk met je lichaam. Daarmee beeld je de letters van het alfabet uit. Zo word je spelenderwijs geconfronteerd met de mogelijkheden en onmogelijkheden van houdingen en bewegingen.



Fiorella & Mayer

- Summarise – main points (short) in own words
- Map – written/spoken text in a spatial representation
- Draw – visual representation of the contents
- Imagine – mental image of the contents
- Self-test - retrieval-based learning
- Self-explain – explain the content to yourself
- Teach – explain to a (fictitious) other
- Enact – task-relevant movements

Fiorella, L., & Mayer, R. E. (2015). *Learning as a generative activity: Eight learning strategies that promote understanding*. Cambridge University Press.

Brod

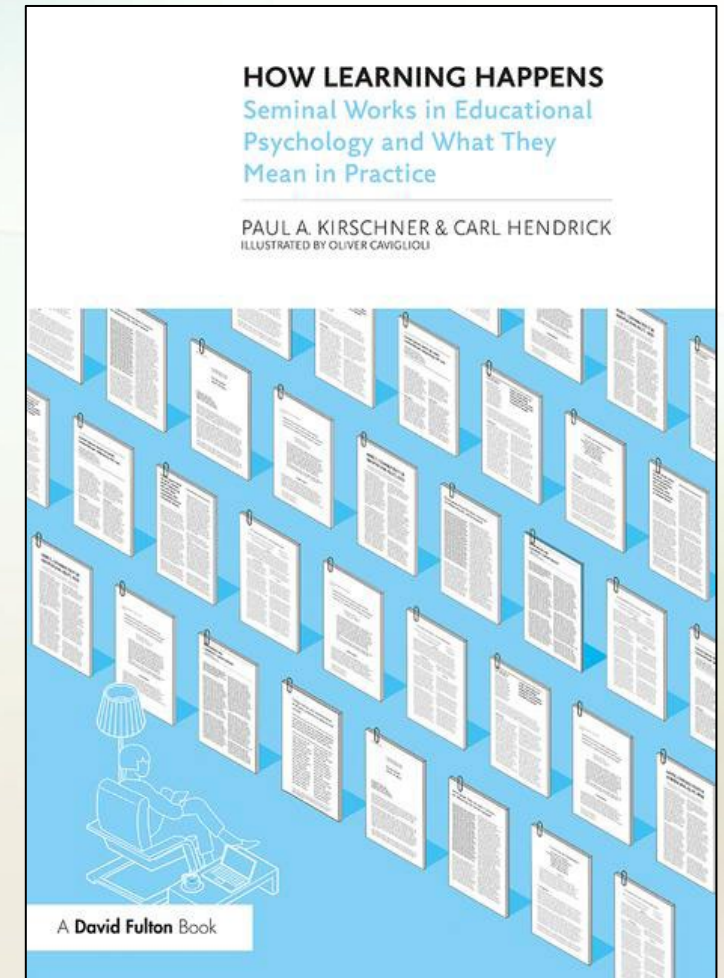
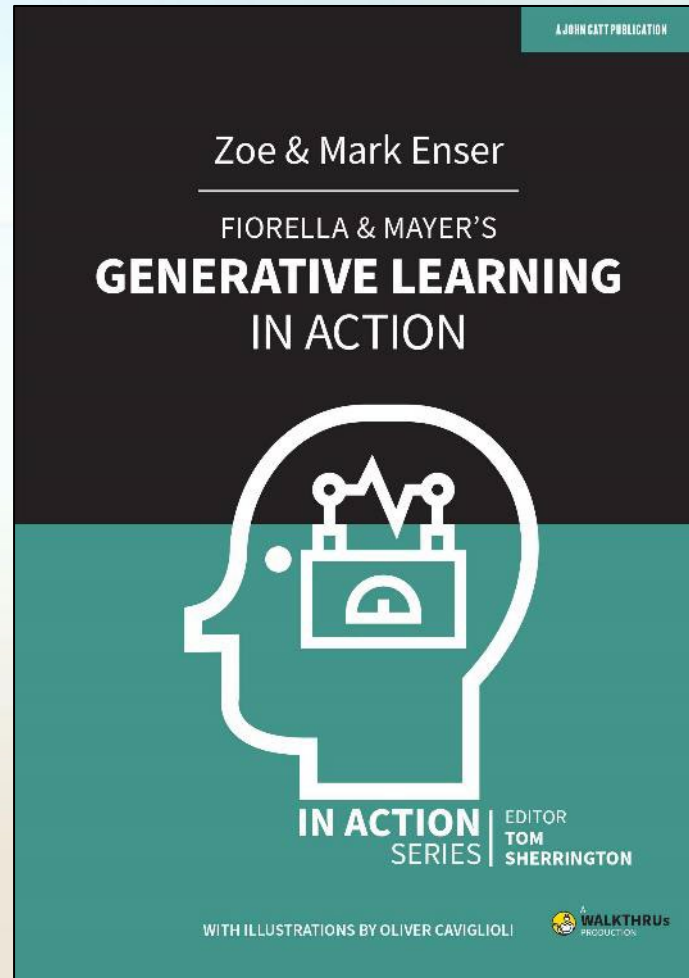
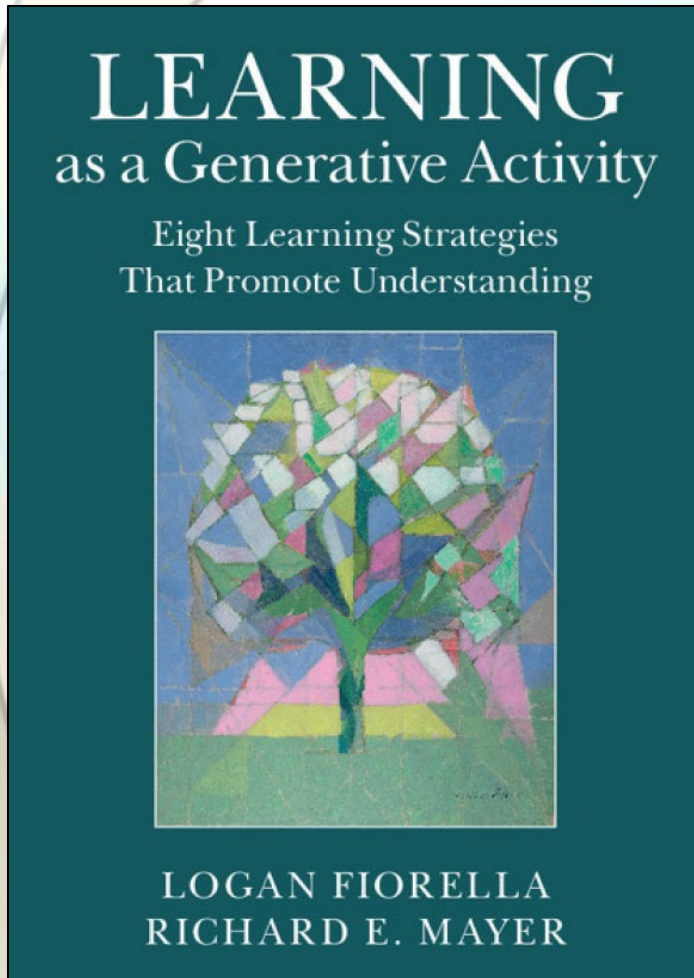
- Concept mapping
- Explaining
- Predicting
- Questioning
- Testing
- Drawing

Brod, G. (2021). Generative learning: Which strategies for what age?
Educational Psychology Review, 33(4), 1295-1318.


Common thread in generative strategies

- Strategy instruction is the most effective if it's explicit
 - Step 1 – Make clear why and how the strategy should be used ('metacognitive talk').
 - Step 2 – Explicitly model and explain what you do and why
 - Step 3 – Give chances to practise (guided to independent) the strategy
 - Step 4 – Give feedback and stimulate reflection on the strategy
- Check the use of the strategies often, including the underlying processes
- Make a plan for the whole school (as the strategies are content-specific, use them in all regular lessons and not in 'learning to learn'-sessions)
- Let students experience a variety of strategies (of test them against each other in different situations)

Want to know/learn more?



kirschnerED

research  ED

@P_A_Kirschner


HOW TEACHING HAPPENS
Seminal Works in Teaching and
Teacher Effectiveness and
What They Mean in Practice

PAUL A. KIRSCHNER, CARL HENDRICK
& JIM HEAL
ILLUSTRATED BY OLIVER CAVIGLIOLI

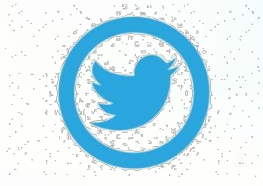


A David Fulton Book

kirschnerED

research  ED

@P_A_Kirschner



@P_A_Kirschner



paul@kirschnered.nl

kirschnerED

research  ED

@P_A_Kirschner