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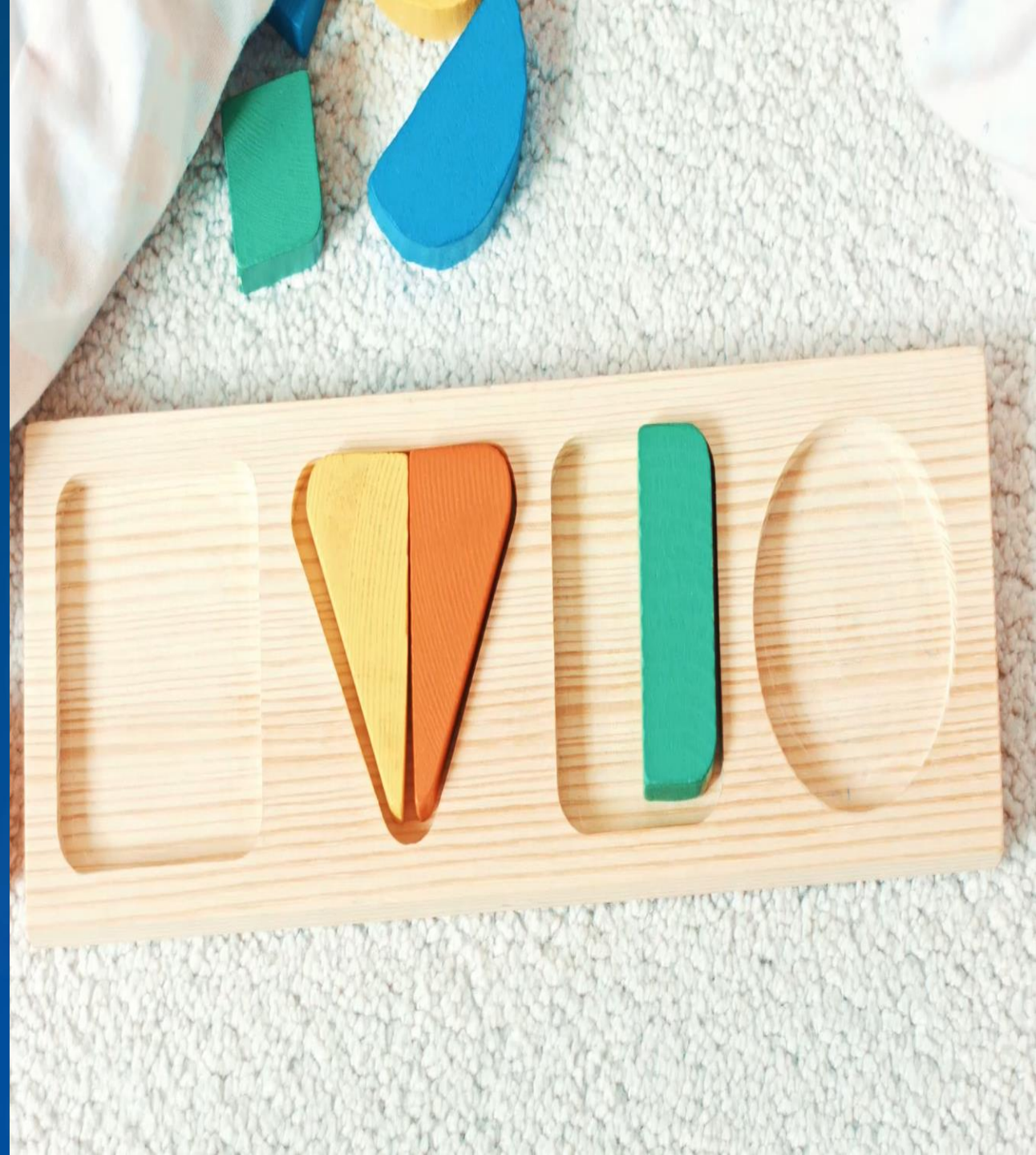
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Cognitive Science in Education

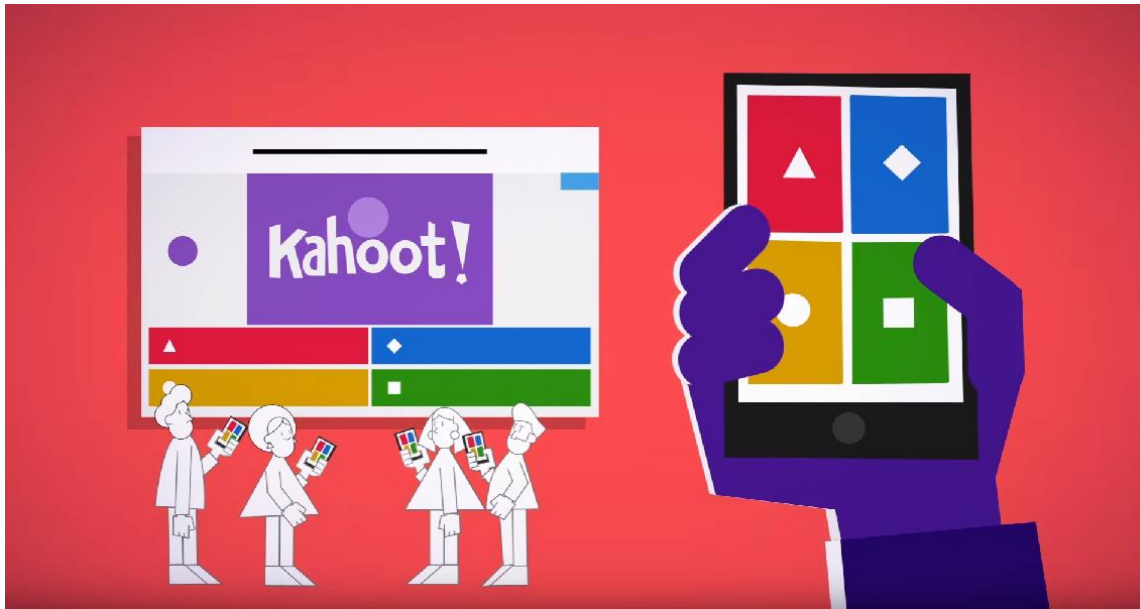
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www.uwtsd.ac.uk



Neuro-myth or Neuro-Science?!



- 10 statements drawn from Macdonald *et al* (2017)
- Some are true, some are false
- If you're not sure, guess!



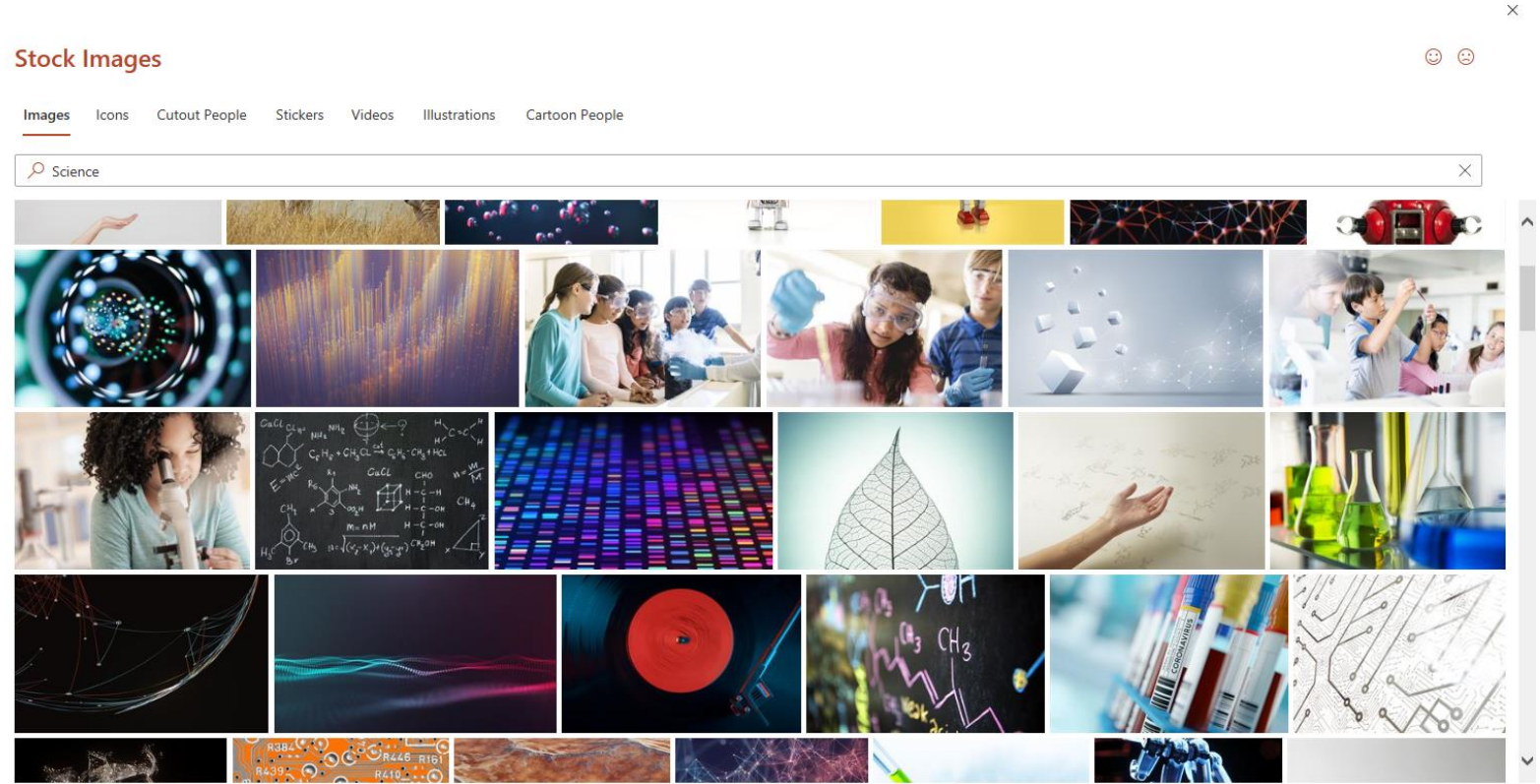
Aims

- Explore current ideas and thinking
- Consider the implications for us as teachers
- Consider the implications for us as learners

Defining terms – Science

Collection of facts?

A process of
becoming incrementally
less wrong about the
world?



Research dispositions

Bod yn ymchwilydd moesegol

- Adfyfrio ar a allai'ch disgwyliad eich hun ar gyfer y dysgwyr hyn fod yn eu rhwystro rhag eu cynnydd. Mae angen i hyn ddigwydd mewn lleoliad adfyfyriol cydweithredol, e.e. adnoddau ar gyfer cyfleoedd cwestiynu.

Bod yn ymchwilydd medrus

- Casglu'r holl dystiolaeth sydd ar gael er budd dysgwyr unigol
- Dod â'r hyn a ddysgwyd hyd yma at ei gilydd i gynllunio ar gyfer dysgu un plentyn / cyfiawnhau penderfyniadau pedagogaidd.
- Defnyddio gwerthuso i werthuso effeithlonrwydd addysgeg a gynlluniwyd.

Bod yn ymchwilydd sgeptigol

- Gwerthuso'n feirniadol ymchwil a theorïau allweddol ac ymchwil sy'n sail i ddatblygiad holistaidd plant a phobl ifanc; gwerthuso a rhannu'r defnydd ar ddamcaniaeth ac ymchwil i arfer personol, gan gynnwys cyfarfod anghenion grwpiau penodol o ddysgwyr; gwerthuso'n feirniadol farn a thybiaethau am grwpiau o ddysgwyr, gan ddarparu cymorth ar gyfer eich penderfyniadau.

Bod yn rhan o Broffesiwn sy'n Ymholi

- Cyfrannu i gymuned o ymarferwyr sy'n ymholi; gwybod a ddylid, pryd a sut i rannu deilliannau'r ymholi ar lawr dosbarth; mynd ati'n rhagweithiol i gyfrannu i amrywiaeth o gynulleidfaoedd sy'n ymwneud ag ymholiad a chanfyddiadau eraill.

Being an ethical researcher

- Reflect on whether your own expectation for these learners might be a barrier to their progress. This needs to take place in a collaborative reflection setting, e.g. questioning opportunity resources.

Being a skilled researcher

- Collation of all available evidence sources to the benefit of individual learners
- Bringing together learning to date to plan for one child's learning / justifying pedagogical decisions.
- Using observation to evaluate the efficacy of planned pedagogy.

Being a sceptical researcher

- Critically evaluate research and key theories and research that underpin the holistic development of children and young people; evaluate and share the application of theory and research to personal practice, including meeting the needs of particular groups of learners; critically evaluate beliefs and assumption about groups of learners, providing support for your decisions.

Being part of an Inquiring Profession

- Contributing to a community of inquiring practitioners; knowing whether, when and how to share outcomes of classroom inquiry; pro-actively contributing to a range of audiences actively engaging with the inquiry and findings of others.

Some background ideas..

1. Humans are not very good at thinking
2. Humans have **working memory** (finite and easy overwhelmed) and **long-term memory** (vast and unconscious)
3. **Thinking** combines information in new ways and happens in the working memory.
4. When it comes to learning, humans are more alike than different



Start at the end

*Learning should be not too hard,
and not too easy.*

*We should organise and
sequence learning to make the
most of the way human beings
learn.*

*Being aware of how your brain
works can guard against built in
weaknesses*

Cognitive Load

Desirable difficulties

Schema

Dual Coding

Retrieval practice

Systems of thinking

Cognitive Load Theory

Formulated by Sweller (1998)

‘The cognitive load involved in a task is the cognitive effort (or amount of information processing) required by a person to perform this task.’

Reif, 2010. Cited in Shibli and West (2018)



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Three forms of cognitive load

Intrinsic

Extraneous

Germane

Three forms of cognitive load

Intrinsic

Intrinsic cognitive

load: the inherent difficulty of the material itself. This can be influenced by prior knowledge of the topic

Extraneous

Germane

Three forms of cognitive load

Intrinsic

Extraneous

Germane

Extraneous cognitive

load: the load generated by the way the material is presented and which does not aid learning



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Three forms of cognitive load

Intrinsic

Extraneous

Germane

Germane cognitive load: the elements that aid information processing and contribute to the development of 'schemas'.

Three forms of cognitive load

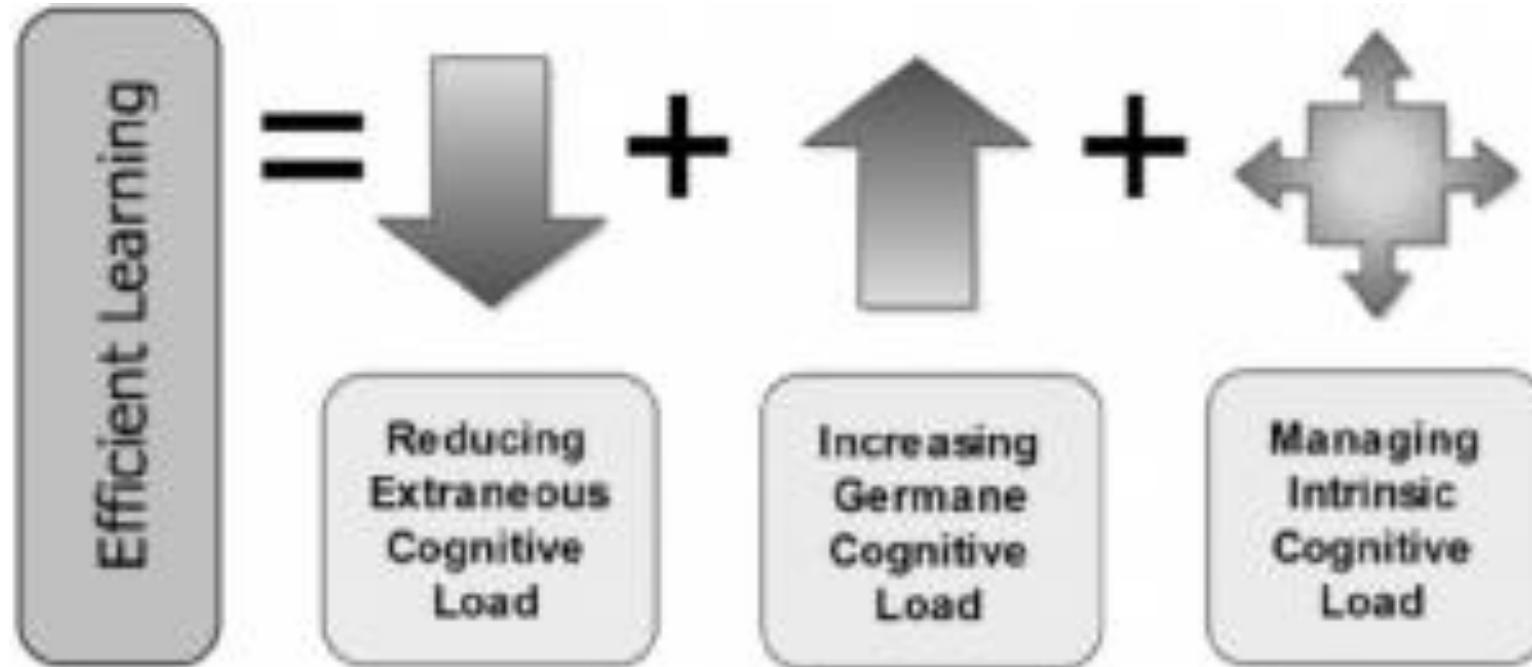


Image credit: Sweller, 2010, cited [in Atkin, 2018](#)



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Discussion



- Discuss in groups how you could use the theory of cognitive load when considering your practice
- What aspects of our subject/phase could contribute to high cognitive load?
- What methods could you use to overcome these?



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So what?



Avoid overloading working memory



Is it suitably broken down?



Do students have the background knowledge to make sense?



Build in clear links to what is already known



Avoid extraneous cognitive load (eg 'busy' slides and worksheets)



Practice your explanations ahead of giving them.

More reading

- <https://impact.chartered.college/article/shibli-cognitive-load-theory-classroom/>
- <https://researchschool.org.uk/durrington/news/cognitive-load-theory-and-what-it-means-for-classroom-teachers>
- <https://researched.org.uk/cognitive-load-theory-in-the-classroom/>



<https://www.youtube.com/watch?v=XPIIm-gtrMM>



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Discussion

In groups, discuss classroom practices that may produce undesirable difficulties

Consider different curriculum areas – how and why could these occur?

Further reading:

<https://researchschool.org.uk/durrington/news/bjorks-desirable-difficulties/>

<https://bold.expert/desirable-difficulties-in-learning/>



Checking in...

**Learning should be not too hard,
and not too easy.**

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sequence learning to make the
most of the way human beings
learn.*

*Being aware of how your brain
works can guard against build in
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Cognitive Load

Desirable difficulties

Schema

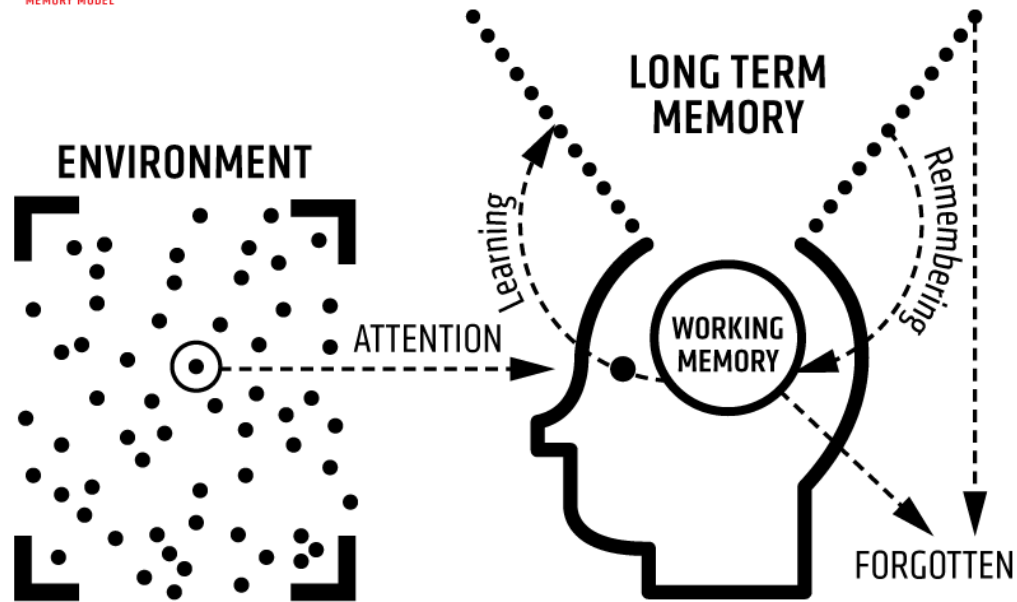
Dual Coding

Retrieval practice

Systems of thinking

How does memory work?

OLI CAV
OLIVER CAVIGLIOLI
@olicav
olicav.com
WILLINGHAM'S SIMPLE
MEMORY MODEL



Working memory is limited
Long term memory is not

Image credit: <https://www.olicav.com/#/posters/>



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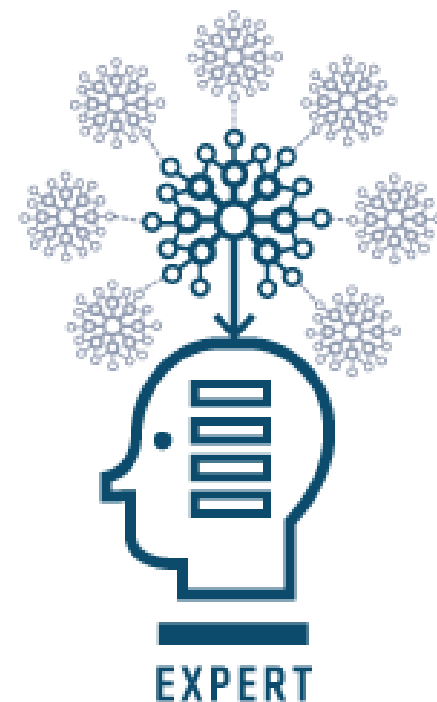


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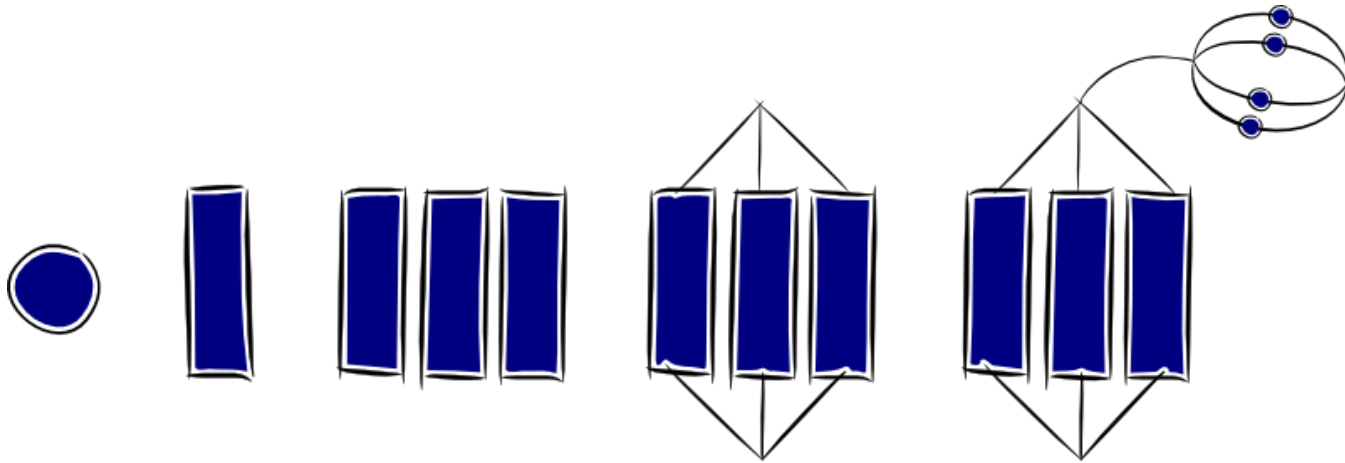
Schema



Image credit: <https://www.olicav.com/#/posters/>



Schema



SOLO Taxonomy (Biggs and Collis, 1982)

Image credit: <https://pamhook.com/solo-taxonomy/>

Putting it to the test!

Dual Coding

Paivio (1971)

Two channels – Verbal and Visual

Separate, but ‘associate connections’ are possible by pairing words and images

Larkin & Simon
(1987)

The visual argument – well constructed diagrams more efficient than text

Dual Coding Oli Cav

Next three slides are taken from Cavioli
(2019) *Dual Coding with Teachers* -
<https://www.olicav.com/#/powerpoints/>



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ACTIVITY 2

Jenny is head of the Humanities faculty.
Fatima is the head of the History department. Tom, Joe and Sue work for Fatima. Harry is the head of the Geography department. Jo, Chaz and Tarnia report to Harry. Sue, Jo, Chaz and Harry are working together on the joint Modern Europe Project.

Who is the highest ranking person on the Modern Europe Project?

Which department has the most people on the Modern Europe project?

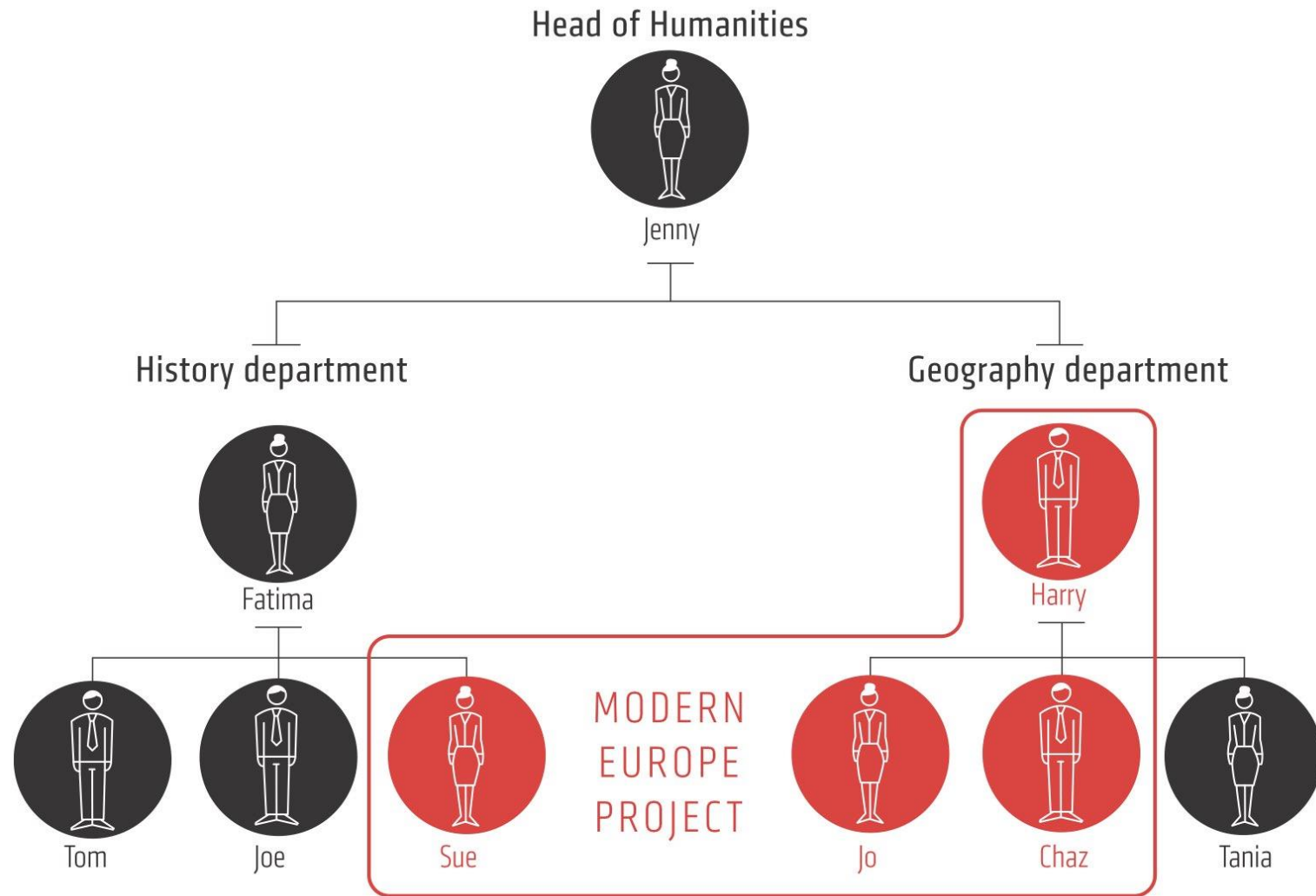
Which people are not involved with the Modern Europe project?

OLI
CAV

Who is the highest ranking person on the Modern Europe Project?

Which department has the most people on the Modern Europe project?

Which people are not involved with the Modern Europe project?



So what?



Never read out your slides



Simple diagrams can be a very powerful learning aid



Using animation in Ppt to introduce one idea at a time is a very powerful technique *(see Oliver Cavioli's website for some great examples)*

Retrieval practice

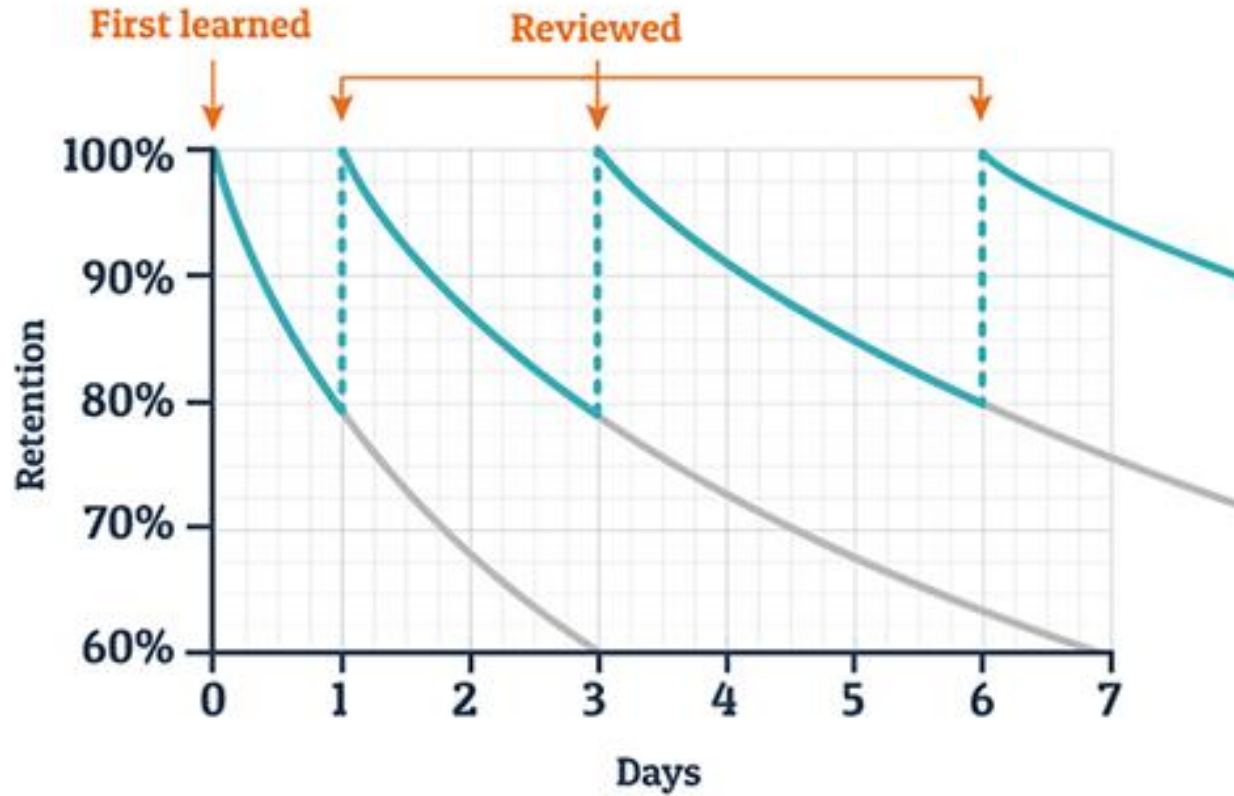
Write down:

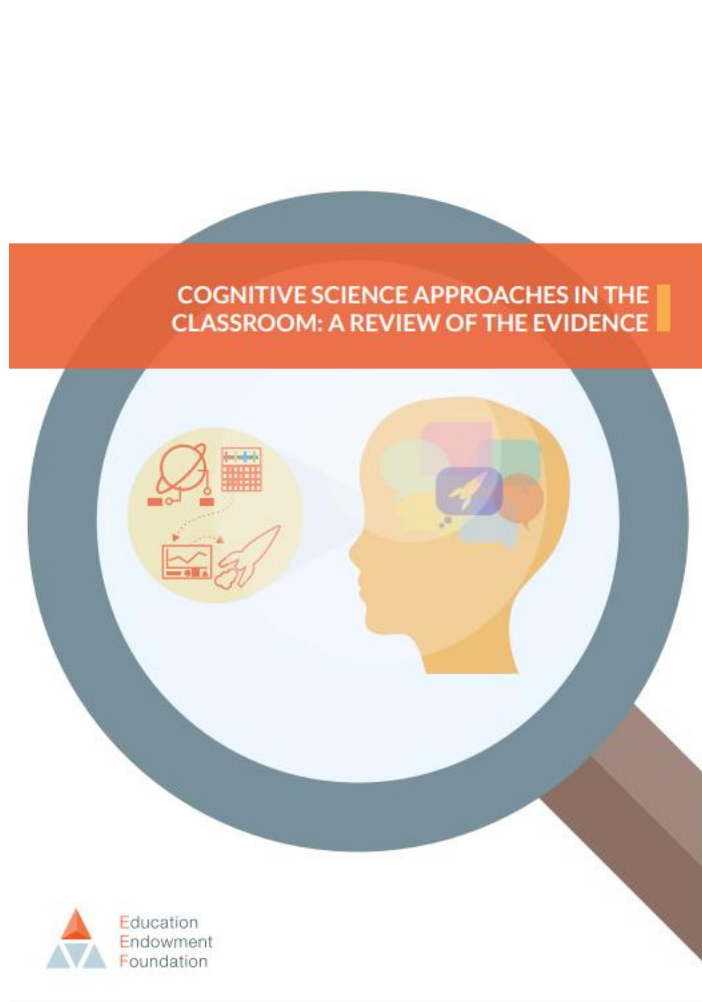
Your UWTSD student number

Your phone number

Your NI number.

Typical Forgetting Curve for Newly Learned Information





[Cognitive science approaches in the classroom | EEF
\(educationendowmentfoundation.org.uk\)](https://educationendowmentfoundation.org.uk)

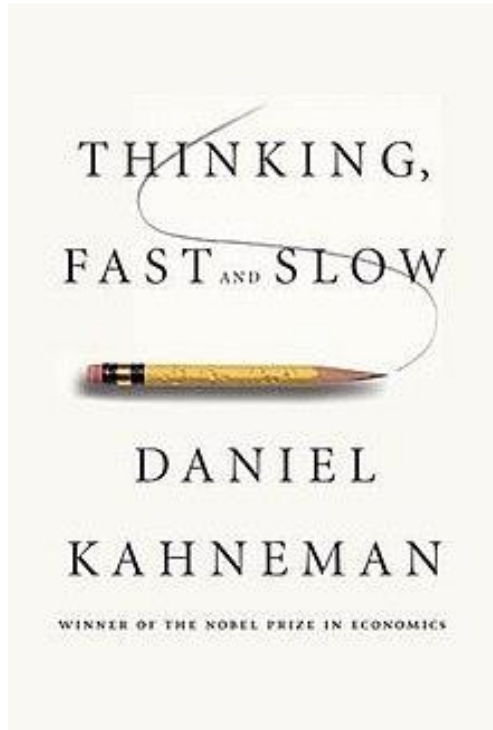
Checking in...

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and not too easy.
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sequence learning to make the
most of the way human beings
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*Being aware of how your brain
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Cognitive Load
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Retrieval practice
Systems of thinking

Thinking fast and slow



Why aren't people very good at thinking?

System 1 – fast, instinctive and emotional

System 2 – slower, more deliberative, logical

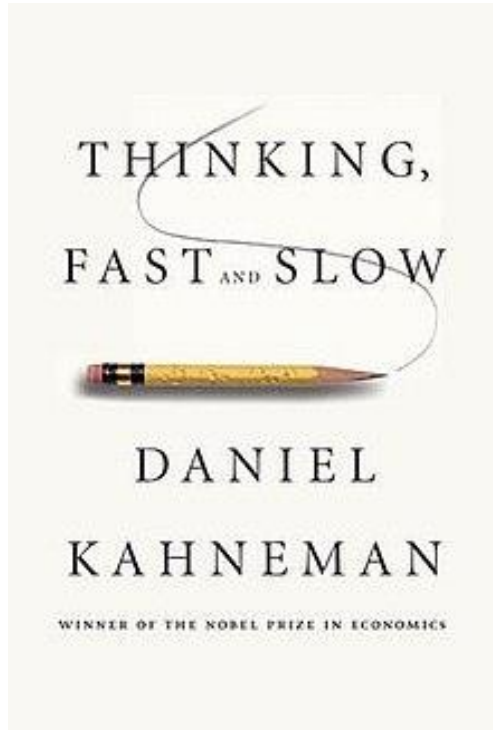


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Heuristics – mental short-cuts that speed up problem solving or decision making

Biases – errors in thinking that can occur when using heuristics



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Be aware of your biases

Confirmation bias – focus on information which confirms your existing ideas

Backfire effect – Evidence to the contrary actually strengthens our beliefs

Pygmalion Effect – your expectations of a learner impacts on your interaction

More on this in Didau (2015)

So what?

Experienced teachers are using heuristics that you haven't developed yet.

Observation alone may not expose the 'why' in the choices that you see.

Learner drivers vs experiences drivers

(almost) the end...

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and not too easy.
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way human beings learn.**

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These ideas are necessary, but not sufficient

It's your job to bring these to life in a 'warm' classroom – Good luck!

<https://www.youtube.com/watch?v=8kt3IyeEYOM>

<https://www.facebook.com/CreateLearnInspire/videos/1262016680625732>



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References

Most links are included on specific slides. Additional full references below

Didau, D., 2016. *What if everything you knew about education was wrong?* Carmarthen. Crown House Publishing.

Education Endowment Foundation (2021). Cognitive Science in the classroom. Available at: <https://educationendowmentfoundation.org.uk/education-evidence/evidence-reviews/cognitive-science-approaches-in-the-classroom> Accessed 10.09.23

Macdonald K, Germine L, Anderson A, Christodoulou J and McGrath LM (2017) Dispelling the Myth: Training in Education or Neuroscience Decreases but Does Not Eliminate Beliefs in Neuromyths. *Front. Psychol.* 8:1314. doi: 10.3389/fpsyg.2017.01314 Available at: <https://www.frontiersin.org/articles/10.3389/fpsyg.2017.01314/full> Accessed 10.09.23

Shibli, D and West, R (2018) COGNITIVE LOAD THEORY AND ITS APPLICATION IN THE CLASSROOM. Impact. Available at: https://my.chartered.college/impact_article/cognitive-load-theory-and-its-application-in-the-classroom/ Accessed 10.09.23

Willingham, D (2009) *Why don't students like school?* San-Francisco Jossey-Bass