ResearchED 2021

The application and misapplication of cognitive science in the classroom

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EEF Cognitive Science in the Classroom Review

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curee

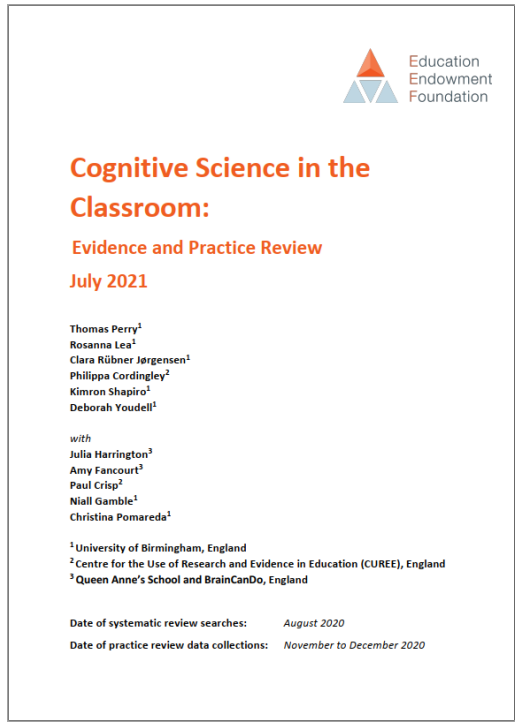
Centre for the Use of Research and Evidence In Education

QA Queen Anne's CAVERSHAM

BrainCanDo

We want to know whether cognitive science techniques work in real classrooms, across the curriculum and for different pupil groups.

Find out more about the review (July 2021)


Education Endowment Foundation

Cognitive Science in the Classroom:

Evidence and Practice Review

July 2021

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Date of systematic review searches: *August 2020*

Date of practice review data collections: *November to December 2020*

- More info: https://eef.li/DoncCq
- Download here: https://eef.li/cog-sci
- Preview talk: https://tinyurl.com/4bxu8tw5
- Summary Twitter thread: https://twitter.com/DrRoseLea/status/1415933389027385344
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The application (and misapplication) of cognitive science in the classroom

Basic and Applied Science

'Basic' cognitive science

Fundamental

'Applied' cognitive science

Realistic

How to make your research *less* realistic:

- Do it in a single school
- Don’t let teachers deliver it
- Use booklets/computer programmes/scripts
- Don’t let teachers or students interact
- Supervise it - step in where needed
- If teachers must deliver, make sure they are experts
- Keep the research to 2 weeks or less. Ideally just a single session.
- Don’t teach in the classroom – pull out small groups.
- Clear comparisons:
  - Distinct conditions
  - Single ability groups
  - Entirely new content
- Make and use your own test

New analysis

Original Review:

- ‘In the classroom’. 202 studies (when grouped)

ResearchED re-analysis:

Also…

- 100+ pupils - 143 left.
- Not delivered by/minimal input from teachers/TAs – 46 left
- 3 weeks+ – 25 left

Spread Thinly

	Area	*Studies*
1	Spaced Learning	2
2	Interleaving	4
3	Retrieval Practice	0 (!)
4	Managing Cognitive Load	3
5	Working with Schemas	6
6	Cognitive Theory of Multimedia Learning	6
7	Embodied Learning and Physical Approaches	1
8	Mixed Strategy Programmes	5

ResearchED re-analysis:

- In the classroom
- 100+ pupils
- Delivered by Ts
- 3 weeks+

Gaps

Strategy	Age	Subjects
Spacing across lessons	Good coverage	
Spacing within lessons		
Interleaving	KS2-3	Vast majority maths
Retrieval	All, but more KS2-3	Good coverage
Worked Examples	KS3-4	Maths and science
Scaffolds/Guidance SBI	KS2-4	Mostly maths, reading comp, or science
Collaborative prob solving	KS2-4	Most maths, science, ICT
Concept/knowledge mapping and organisation	KS2-3	Most organised text using concept map
Schema/concept comparison and conflict	KS3	All maths and science
Visual representation	KS2-4	2/3 maths and science (some other)
Diagrams	KS3-4	Most maths and science
Spatial, visualisation and simulation approaches	EY-KS2	spatial visualisation in maths
Embodied learning	EY-KS3	range of subject areas
Mixed Strategy Programmes	KS3	maths and science

Mixed Strategy Programmes

Study	Subject	Students	Strategy	Result
Cromley et al. (2016)	Science	9,611 7th and 8th grade	Curriculum + CPD including several of: • Spaced retrieval (daily quizzes) • Worked examples with self explanation • Concept comparisons • Dual coding/ diagrammatic reasoning • Visualization exercises	**6 teacher units:** • 2 moderate postive. 4 not statisticall signficant (one –ve)
Davenport et al. (2020)	Maths	2,595 7th grade		• Positive but small and not statistically significant
Yang et al. (2020)	Science	5,508 7-8th grade		
Schunn et al. (2018)	Science	6,400 to 3,200 7,600 to 4,200 7-8th grade		• Small postive to small negative (most not stat sig)

Mixed Strategy Programmes (continued)

Classroom-based instruction requires simultaneously integrating and applying a variety of learning principles in a complex and dynamic system that involves teachers and entire classrooms of students over months and years (p.516) …

Practitioners often struggle to interpret and integrate abstract, general principles with everyday instruction …

Instructional design is ultimately a form of engineering, moving research into practice requires that theories are integrated and applied with a focus on practical impact and evaluation at scale (Burkhardt, 2006; Kirschner, Verschaffel, Star, & Van Dooren, 2017). (p.517)

(Davenport et al., 2020)

Mixed Strategy Programmes (continued)

The Cog-sci teachers might have benefited more if our professional development (PD) had offered more direct experiences with the optimal learning environment they are expected to construct …

Previous research has shown that what teachers learn in PD depends largely on the existing knowledge they bring to the activity and that they can have quite different takeaways from their learning experiences …

Personalizing PD to address teachers' particular circumstances, knowledge, and experience holds promise for increasing their effectiveness.

(Yang et al., *2020, p.558)*

The role of CPDL evidence in supporting the translation of cognitive science evidence into practice

Use of evidence – some established models

- One way of conceptualising use of research is implementation – which privileges research knowledge over knowledge of pupils and practice – helps navigate complexity but risks solutions in search of problems
- Another is Knowledge Mobilisation (cf OISIE) – which brings precision - but it is teachers and leaders who we need to mobilise if pupils are to benefit
- CUREE's approaches use of research as a process of finding evidence-rich ways of supporting teachers' and leaders' continuing professional development *and learning* in service of pupil learning- as a way of tackling enduring learning challenges

Why this focus?

- The key messages from EEF Cognitive science review:
  - Point directly towards the skilled professional role of teachers and leaders in interpreting research findings for their context
  - They highlight importance of working from principles revealed by basic science towards tackling “wicked” learning challenges - not following recipes
  - Using results of basis and applied research well is complicated
- The findings of Developing Great Leadership of CPDL point the centrality of metacognition to teachers professional learning
- How does this connect with evidence about metacognition for pupils?
- (A closing note) This emerged as critical to strategic success during an OECD country review I participated in in South Korea

EEF Guidance re metacognition for pupils

- Explicitly teach metacognitive strategies, including how to plan, monitor, evaluate and reflect on your learning
- Teachers need to:
  - Model thinking and provide scaffolded tasks to help pupils develop their metacognitive and cognitive skills
  - Set an appropriate level of motivating challenge to develop pupils' self-regulation and metacognition
  - Promote and develop metacognitive classroom talk
  - Teach pupils how to organise and effectively manage their learning independently, using feedback to help them evaluate their progress

A subject contextualised version – CASE and CAME

- **Concrete preparation**, to ensure pupils understand the problem
- **Cognitive conflict** - setting up situations that help pupils explore situations that are in tension with previous experience
- **Social construction** - pupils working together on challenging activities designed to help them construct new joint understanding g so they can understand and internalise it for use later and prompt them to articulate their own reasoning
- **Bridging** - the conscious transfer of a reasoning pattern from its initial context to a new context, which when successful, produces both a generalisation and a consolidation of the reasoning pattern
- Shayer and Adey, Really Raising Standards- in Maths and science

Designing CPDL effectively means

- Focussing CPDL via:
  - relevant, well evidenced content; *and*
  - building on deep understanding of teachers' and their pupils' starting points
- Aligning CPDL with teachers' aspirations for pupil achievement and wellbeing
- Emphasising developing practical theory alongside content and pedagogy (to build professional self awareness and enable informed contextualisation)

Designing CPDL effectively means

- Making extensive use of formative assessment to enable teachers (and facilitators) to connect and explore connections between new and existing learning and internalised knowledge and beliefs
- Rooting collaboration in dialogue about;
  - iterative experiments with new approaches; and
  - refining them in the light of evidence about how pupils' respond

EEF Guidance re metacognition	A subject specific model – CASE and CAME	Effective CPDL evidence
Activate prior knowledge	Concrete preparation to identify prior understanding	Identify prior knowledge, skills & aspirations for pupils
Teach metacognitive strategies, including how to organise, plan, monitor, evaluate and reflect on their learning independently	Help pupils to articulate their own reasoning to understand and internalise it so it can be used later on	Introduce new approaches via modelling, formative assessment and structured protocols
Model your own thinking and provide scaffolded tasks	Bridging – conscious transfer of a reasoning pattern from one context to another	Prompt structured, sustained, iterative, experimentation and reflection to support application and elicit underpinning principles,

EEF guidance on metacognition	CASE and CAME	Effective CPDL
Set challenges to develop pupils' self-regulation and metacognition without overloading their cognitive processes	Work through cognitive conflicts/ and puzzling ideas and phenomena which are in tension with prior experience	Develop understanding of why things do and don't work in different contexts to create practical theory alongside new approaches
Promote and develop guided and focussed metacognitive talk in the classroom	Working together on the challenging activity to articulate their thinking and construct new joint understandings	Focus dialogue between peers and specialists on how pupils respond to what teachers are learning, why they do so and how this relates to principles from basic science

Three reflections on metacognition and CPDL

- Tension in acting on learning from CPD inputs. For teachers to use CPDL as a prompt for developing metacognition they must both:
  - develop their metacognitive control over the ideas and approaches involved to interpret them accurately for context; and
  - internalise them to the point of automaticity so they can focus in class on how pupils are responding to the changes they are making
- Deliberately focussing CPDL on helping teachers develop metacognitive control of the cognitive science principles is likely to be revealing as well as supportive of pupil progress
- Teachers act within their schools' models of pedagogy and in this country much CPDL and sue of research is framed by school policies.
- What do we know about leadership of CPDL that might help?

Effective leaders of great CPDL

- Position CPDL as a process for taking shared responsibility for excellence in pupil achievement *and* wellbeing
- Focus on teachers' professional growth as well as developing their knowledge and skills and make explicit the links between the two
- Promote professional learning as a professional responsibility
- Model openness to deep professional/ leadership learning – eg via curriculum development and the process of policy development

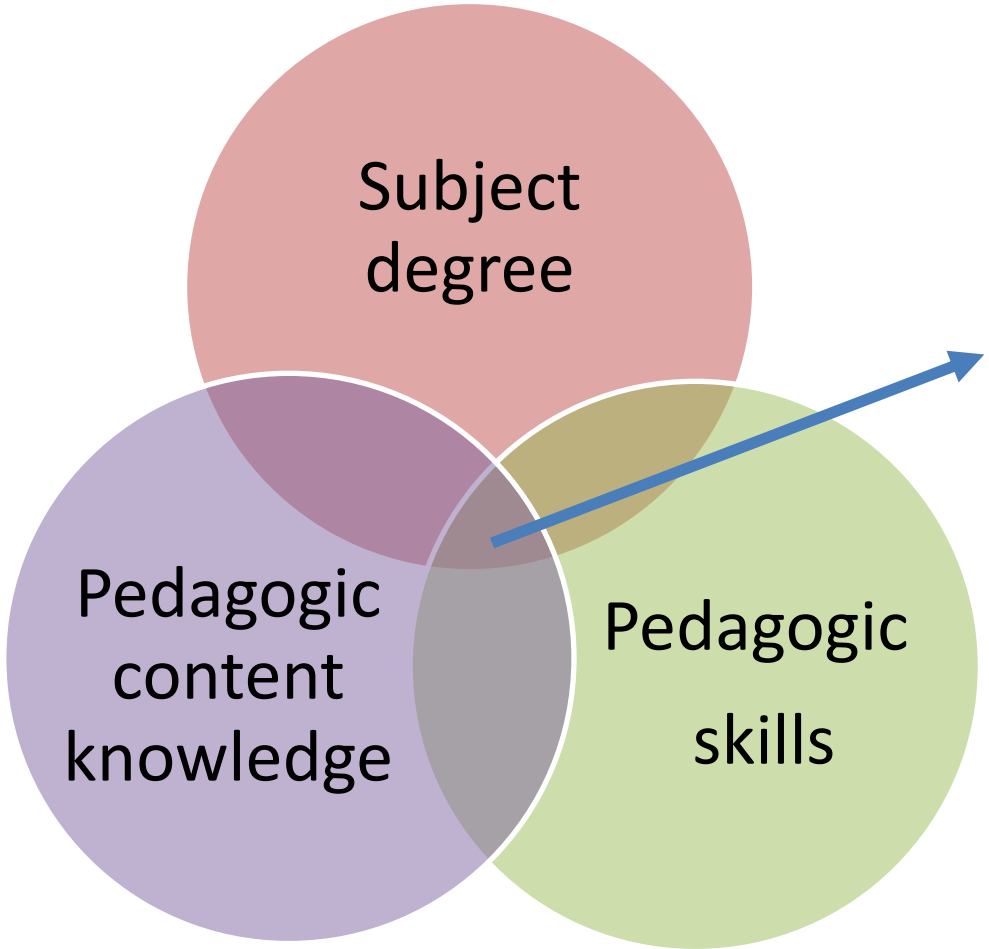
- http://www.curee.co.uk/node/5201

Effective leaders of great CPDL

- Design structures/systems around helping teachers manage complexity and identify and create tools that help teachers manage the:
  - Cognitive
  - Practical; and
  - Emotional

  demands that CPDL content and systems make on teachers
- Recognise and mobilise specialist contributions to CPDL (including CPDL expertise)to enable depth
- Emphasise developing practical theory alongside content and pedagogy to build professional self awareness and enable informed contextualisation

What might this look like? An analogy from South Korea?



Critiquing textbooks (aka Cog science based approaches) for different learning challenges and groups of students

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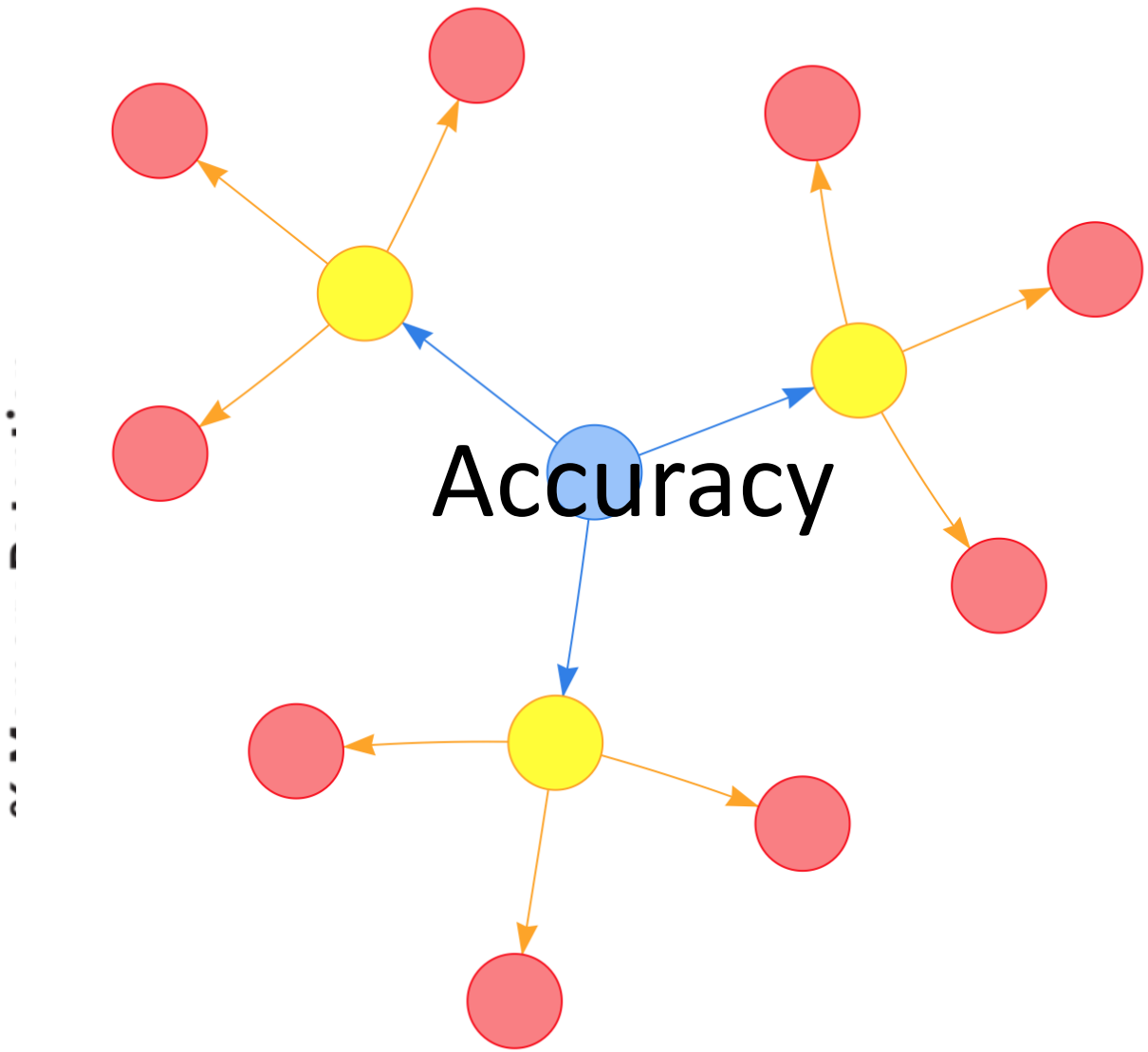
Selected findings and examples from the applied evidence

Applying Principles



Applying Retrieval Practice

- Selecting the content
  - Foundational
  - Variation (with/across)
  - Difficulty
- Formative assessment/Feedback
- Motivation/test anxiety
- Type of retrieval activity
- Workload/planning/classroom management etc. etc.

Lost in translation

"I suppose the risk is that the purity of the research becomes slightly distorted the further it goes into different areas of the school – you might go into Art and find something you said about retrieval practice looks completely different. And suddenly, you're not 100% sure whether it is the same thing anymore!"

School leader, from Morris, Perry & Asquith et al., (2020)

MORRIS, R., PERRY, T. & ASQUITH, S. (2020) The Opportunities and Challenges of Leaders Using Evidence in Education. In Gorard, S. (Ed.) Getting evidence into education. London: Routledge

Across all the strategies

- Spacing
  - Curriculum planning and assessment
- Interleaving
  - Which concepts/topics/information/strategies should be interleaved and why?
- Managing cognitive load
  - How to navigate continua:
    - Unguided vs. guided
    - ‘Novices’ vs. ‘experts’ (Novel vs. familiar content)
    - Generic vs. specific knowledge and skills
    - Defined vs. undefined problem/content spaces
    - Low vs. high element interactivity
  - Emotions
  - What reducing extraneous load in subject areas/pedagogy
- Working with schemas and generative learning

Dual Coding, the Cognitive Theory of Multimedia Learning

- Informative, illustrative, decorative
- Length of presentation
- Spoken vs. written verbal (former better)
- Expert reversal
- Reverse expert reversal?? Novice reversal?
- Abstract/concrete
- Relevant vs. tenuous
- Essential vs. supplementary info
- Student vs. teacher generated content
- Learner control in a multimedia environment
- Transfer of learning vs. retention
- Short term/long-term retention
- Use of signals/cues/arrows or not
- Animation versus static (and length)
- Anthropomorphic (*despite* cog load)

Principles and practicalities a) matter and, b) interact

Teachers, teaching	**Pupil individual factors** (potentially different for each student)
Classroom/social environment	**Activity, Topic and Subject** (and stage within these)

Reflections

Teachers work from general to specific (and the evidence might not help with that!)

1. Retrieval works (i.e., strengthens memory)
2. Retrieval practice works
3. … in specific:
   - Subjects
   - Age ranges
4. … using specific T&L activities (e.g., quizzing)
5. … for specific learning objectives/types of content
6. … for specific conditions:
   - Teacher experiences and expertise
   - Pupil prior knowledge
   - Pupil motivation
7. For my Year 4 maths lesson on fractions on Tuesday morning, delivered to mixed ability class with me working with a target group.

Autonomy / Ownership

*"I think if the evidence directly contradicts what people – through either their experience or their hunches – believe to be true, that one should pay attention to the evidence. You know, I think there comes a point, **where the evidence is robust enough**, where one has to say there is a limit to professional judgement."*

Head of Teaching and Learning, from Morris, Perry & Asquith et al., (2020)

Knowing versus doing

"It is all very well to find good evidence and to translate good evidence and even to communicate good evidence. But getting practitioners to change their actual practice is the final and most difficult hurdle to get across."

School leader, from Morris, Perry & Asquith et al., (2020)

Reflections on the (mis) application of cognitive science

- Urgent need for applied research
  - Robust trials
  - Reviews (with an applied focus)
  - Practitioner research
- Subject-specificity
- New tools for thinking?

Thanks

Q&A

Get in touch:

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