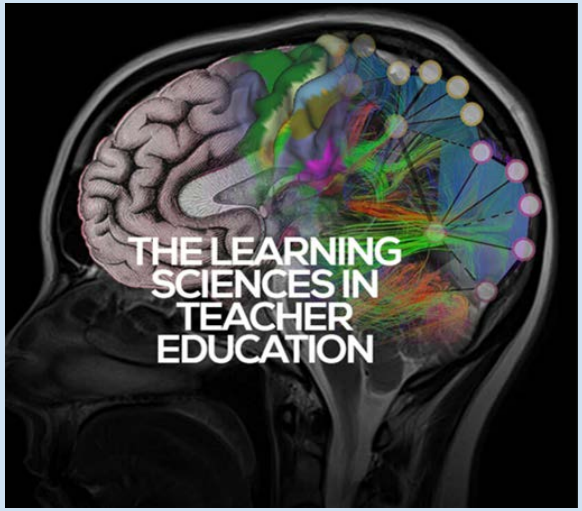
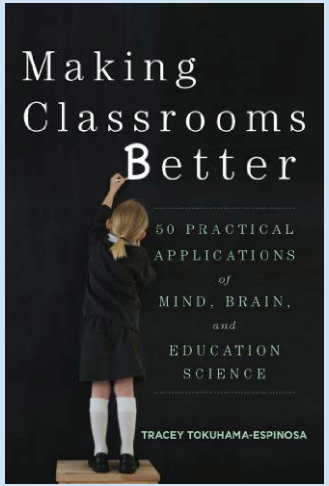
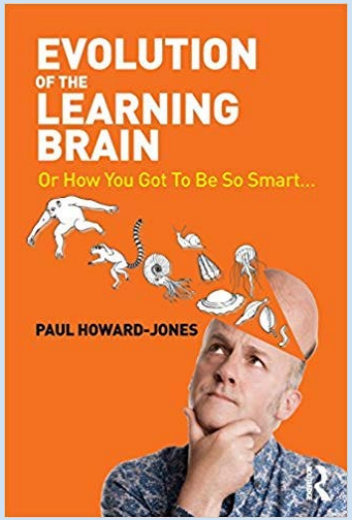
Learnus
FutureEd23

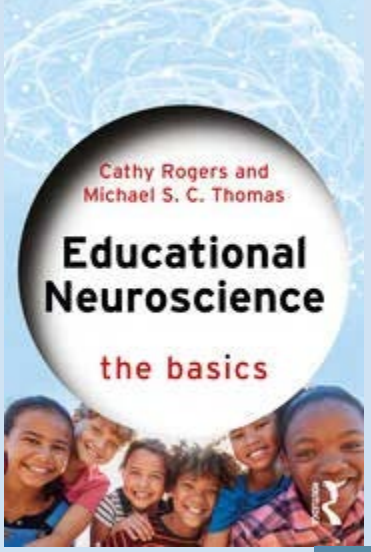
The Place of Educational Neuroscience in Teacher Education

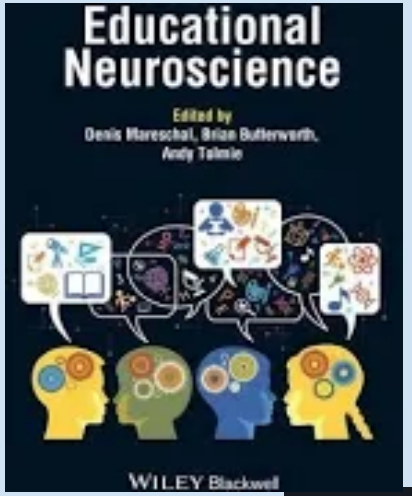
Professor Paul Howard-Jones, University of Bristol
&
Dr Kendra McMahon, Bath Spa University

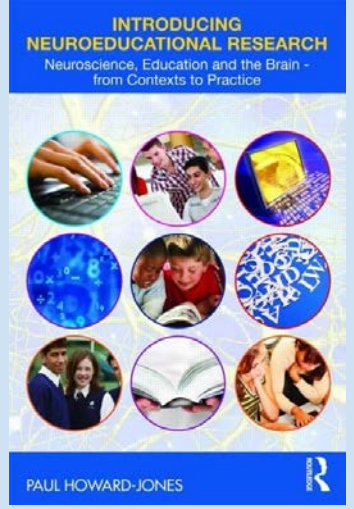


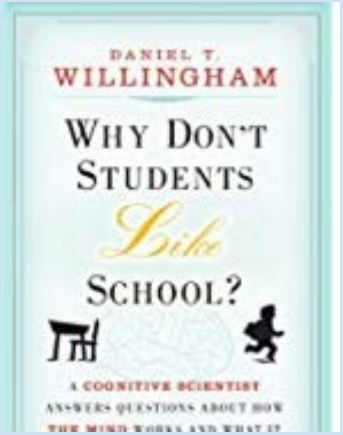

Making Classrooms Better
50 PRACTICAL APPLICATIONS of MIND, BRAIN, and EDUCATION SCIENCE
TRACEY TOKUHAMA-ESPINOSA

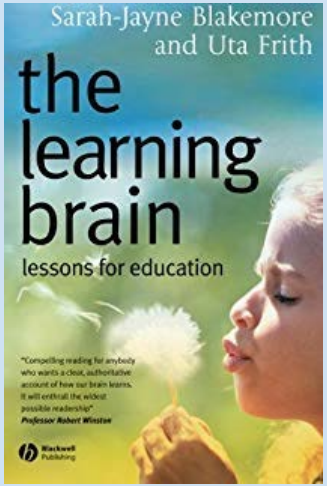

EVOLUTION OF THE LEARNING BRAIN
Or How You Got To Be So Smart...
PAUL HOWARD-JONES

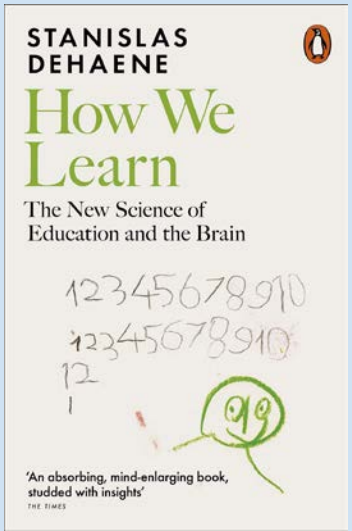

Cathy Rogers and Michael S. C. Thomas
Educational Neuroscience
the basics

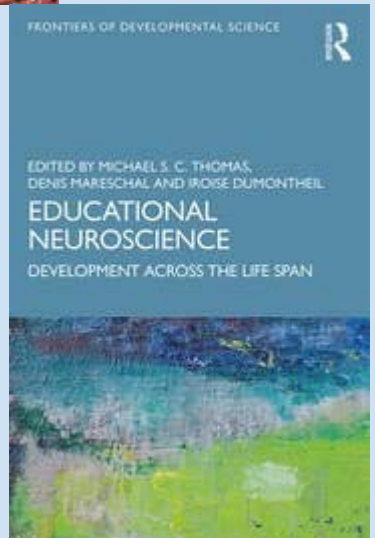

Educational Neuroscience
Edited by
Denis Mareschal, Brian Butterworth, Andy Tolmie
WILEY Blackwell

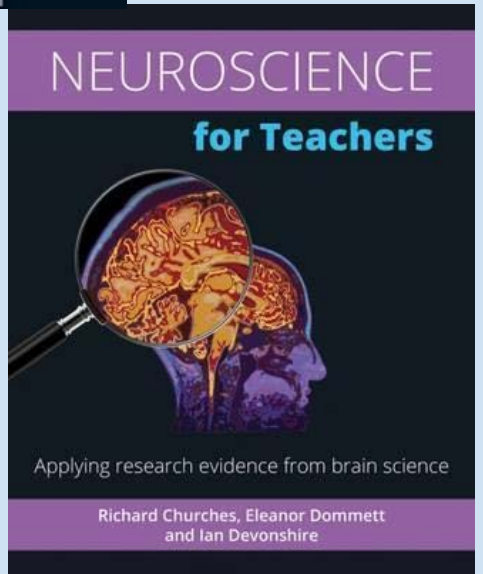

INTRODUCING NEUROEDUCATIONAL RESEARCH
Neuroscience, Education and the Brain - from Contexts to Practice
PAUL HOWARD-JONES


DANIEL T. WILLINGHAM
WHY DON'T STUDENTS Like SCHOOL?
A COGNITIVE SCIENTIST


Sarah-Jayne Blakemore and Uta Frith
the learning brain
lessons for education

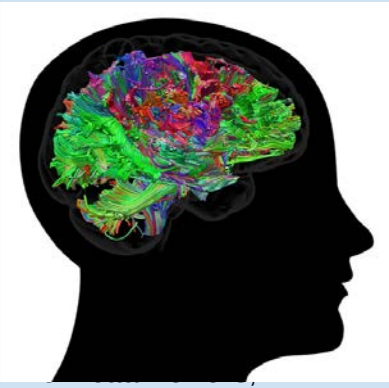

STANISLAS DEHAENE
How We Learn
The New Science of Education and the Brain
'An absorbing, mind-enlarging book, studded with insights'


FRONTIERS OF DEVELOPMENTAL SCIENCE
EDITED BY MICHAEL S. C. THOMAS, DENIS MARESCHAL AND IROISE DUMONTHEIL
EDUCATIONAL NEUROSCIENCE
DEVELOPMENT ACROSS THE LIFE SPAN


NEUROSCIENCE
for Teachers
Applying research evidence from brain science
Richard Churches, Eleanor Dommett and Ian Devonshire

The Learning Sciences in Primary Initial Teacher Education
- responding to the rise of educational neuroscience and then to the Core Content Framework

Kendra McMahon, Pete Etchells, Alison Lee, Kerry-Anne Barber, Lisa Howarth, Darren McKay, Chloe Shu-Hua Yeh and many other PGCE colleagues.



NatBrainLab. CC BY

Design-Based Research (e.g. Anderson & Shattuck, 2012)
Dual outcomes:

- Designed interventions/materials
- Principles and guidelines

wellcome

BATH SPA UNIVERSITY

‘Critical consumer’ approach’ to brain-based claims

We must praise children for their effort, not tell them they are clever, to foster a growth mindset. Anyone can achieve anything if they believe in themselves!

CONSULTANT

She’s like me - no good at maths, but more of a right brained creative thinker.

COLLEAGUE

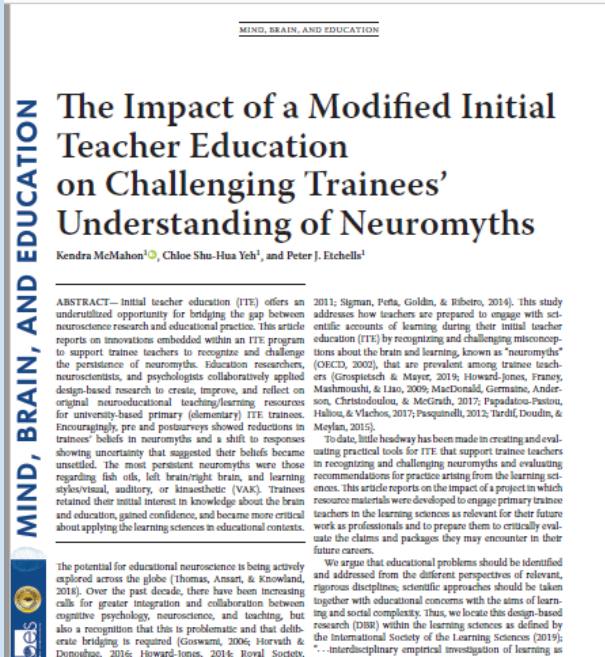
He’s a kinaesthetic learner – he only learns by doing. Have you done a VAK test with your class?

TEACHING ASSISTANT

If you give children frequent tests and quizzes it really helps them to remember the facts.

HEADTEACHER

Unsettling belief in neuromyths



MIND, BRAIN, AND EDUCATION

MIND, BRAIN, AND EDUCATION

The Impact of a Modified Initial Teacher Education on Challenging Trainees’ Understanding of Neuromyths

Kendra McMahon[1], Chloe Shu-Hua Yeh[1], and Peter J. Etchells[1]

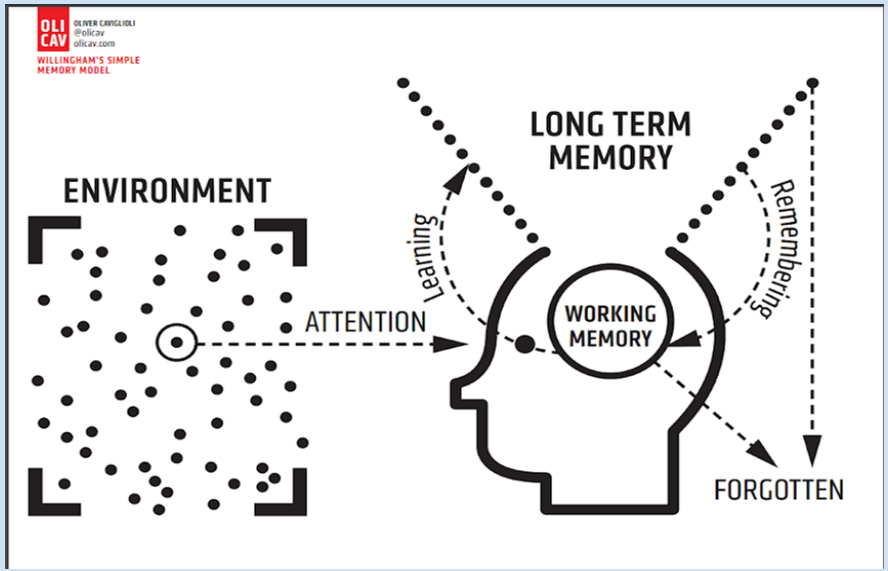
ABSTRACT— Initial teacher education (ITE) offers an underutilized opportunity for bridging the gap between neuroscience research and educational practice. This article reports on innovations embedded within an ITE program to support trainee teachers to recognize and challenge the persistence of neuromyths. Education researchers, neuroscientists, and psychologists collaboratively applied design-based research to create, improve, and reflect on original neuroeducational teaching/learning resources for university-based primary (elementary) ITE trainees. Encouragingly, pre and postsurveys showed reductions in trainees’ beliefs in neuromyths and a shift to responses showing uncertainty that suggested their beliefs became unsettled. The most persistent neuromyths were those regarding fish oils, left brain/right brain, and learning styles/visual, auditory, or kinaesthetic (VAK). Trainees retained their initial interest in knowledge about the brain and education, gained confidence, and became more critical about applying the learning sciences in educational contexts.

The potential for educational neuroscience is being actively explored across the globe (Thomas, Ansari, & Knowland, 2018). Over the past decade, there have been increasing calls for greater integration and collaboration between cognitive psychology, neuroscience, and teaching, but also a recognition that this is problematic and that deliberate bridging is required (Goswami, 2006; Horvath & Donoghue, 2016; Howard-Jones, 2014; Royal Society, 2011; Sigman, Peña, Goldin, & Ribeiro, 2014). This study addresses how teachers are prepared to engage with scientific accounts of learning during their initial teacher education (ITE) by recognizing and challenging misconceptions about the brain and learning, known as “neuromyths” (OECD, 2002), that are prevalent among trainee teachers (Grospietsch & Mayer, 2019; Howard-Jones, Franey, Mashmoushi, & Liao, 2009; MacDonald, Germaine, Anderson, Christodoulou, & McGrath, 2017; Papadatou-Pastou, Haliou, & Vlachos, 2017; Pasquinelli, 2012; Tardif, Doudin, & Meylan, 2015).

To date, little headway has been made in creating and evaluating practical tools for ITE that support trainee teachers in recognizing and challenging neuromyths and evaluating recommendations for practice arising from the learning sciences. This article reports on the impact of a project in which resource materials were developed to engage primary trainee teachers in the learning sciences as relevant for their future work as professionals and to prepare them to critically evaluate the claims and packages they may encounter in their future careers.

We argue that educational problems should be identified and addressed from the different perspectives of relevant, rigorous disciplines; scientific approaches should be taken together with educational concerns with the aims of learning and social complexity. Thus, we locate this design-based research (DBR) within the learning sciences as defined by the International Society of the Learning Sciences (2019); “. . .interdisciplinary empirical investigation of learning as

Model of learning dominant in Early Career Framework and ITT Core Content Framework (2019)



https://www.olicav.com/#/powerpoints/

"Content should **focus on empirical generalizations**—regularities in children's thinking, emotion,and motivation.

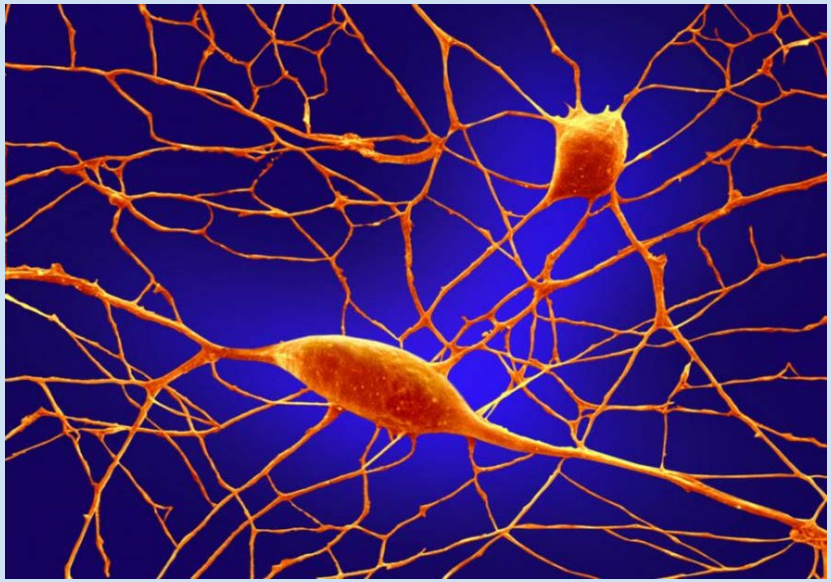
Students should encounter only a **minimal number of simplified theories** to integrate these empirical generalizations,

and those simplified theories should be drawn from a **single set of epistemic assumptions."**
Willingham (2017: 172)

How Pupils Learn (Standard 2 – 'Promote good progress')

Learn that…	Learn how to…
7. Regular purposeful practice of what has previously been taught can help consolidate material and help pupils remember what they have learned. 8. Requiring pupils to retrieve information from memory, and spacing practice so that pupils revisit ideas after a gap are also likely to strengthen recall. 9. Worked examples that take pupils through each step of a new process are also likely to support pupils to learn. Introduces consolidation of learning through retrieval practice	• *Linking what pupils already know to what is being taught (e.g. explaining how new content builds on what is already known).* **Increase likelihood of material being retained, by:** • *Observing how expert colleagues plan regular review and practice of key ideas and concepts over time (e.g. through carefully planned use of structured talk activities) and deconstructing this approach.* • *Discussing and analysing with expert colleagues how to design practice, generation and retrieval tasks that provide just enough support so that pupils experience a high success rate when attempting challenging work.* **And - following expert input - by taking opportunities to practise, receive feedback and improve at:** • *Balancing exposition, repetition, practice and retrieval of critical knowledge and skills.* • *Increasing challenge with practice and retrieval as knowledge becomes more secure (e.g. by removing scaffolding, lengthening spacing or introducing interacting elements).*

Neuroscience offers another model of learning as making and changing connections within the brain - and how that happens as a result of living in the social and material world.



Credit: Purkinje neurons in culture. Annie Cavanagh. (CC BY-NC 4.0)

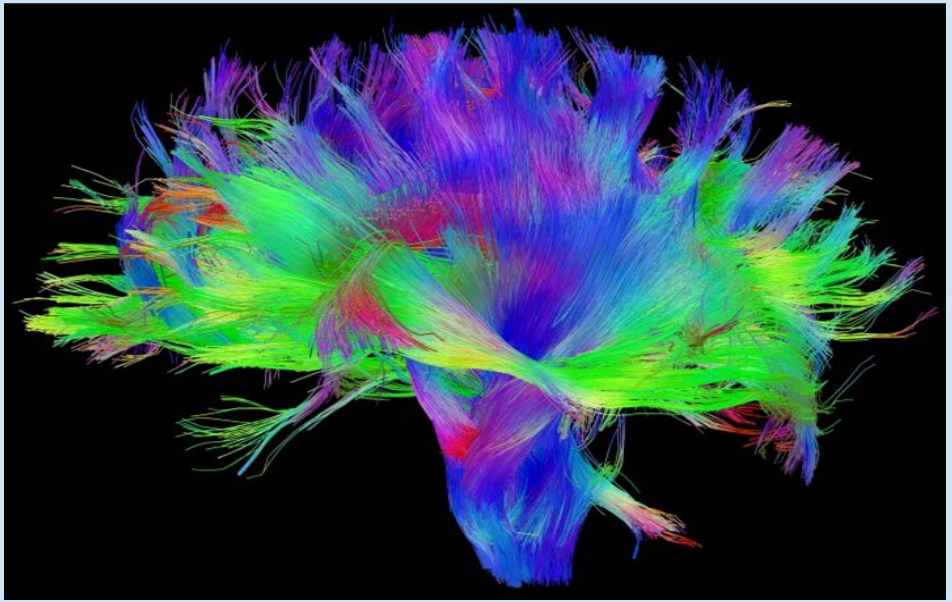
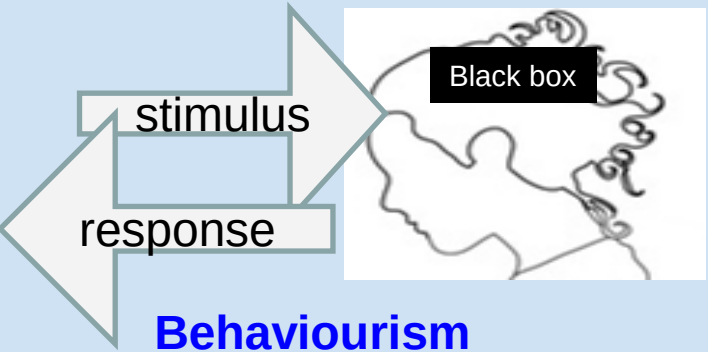
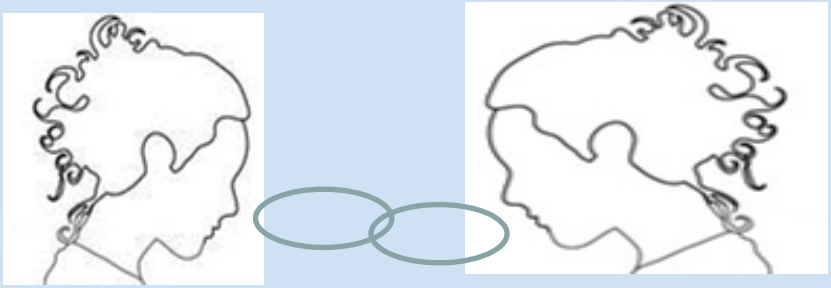


Image courtesy of the USC Mark and Mary Stevens Neuroimaging and Informatics Institute (www.ini.usc.edu) for the Human Connectome Project

Multiple views of learning encountered in ITE ..

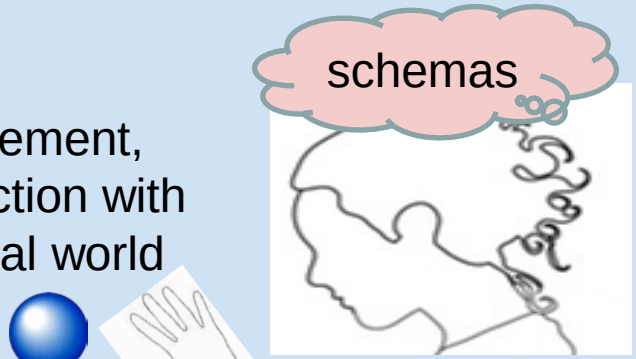


Behaviourism

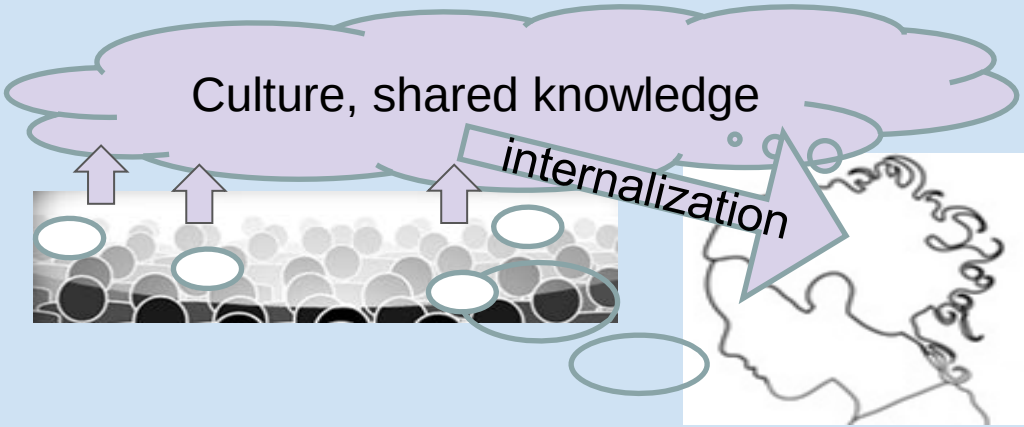


Social constructivism

Active engagement, Interaction with physical world



Piagetian Constructivism



Sociocultural theory

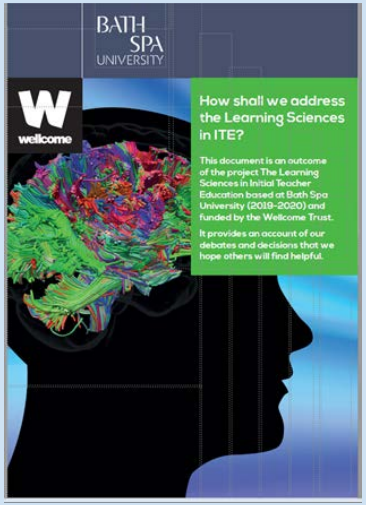
Wider educational concerns about the CCF

- Is it really based on the ‘best available educational research’?
- Presents teaching as a decontextualised series of interventions with narrow objectives
- “permission to think” is left in the hands of the “expert researchers”

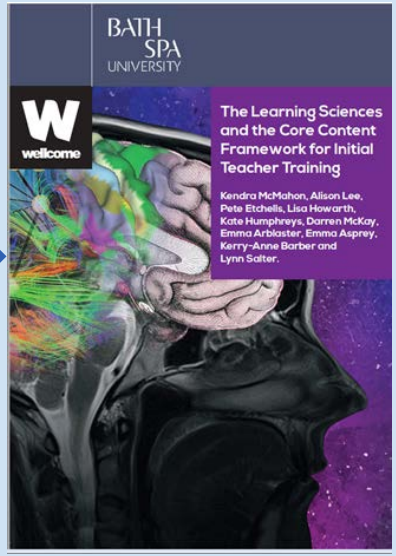
Horden and Brooks (2023)

“…Empirical generalizations usually apply to one aspect of a complex situation, but educators must consider all aspects of the situation…Willingham (2019)

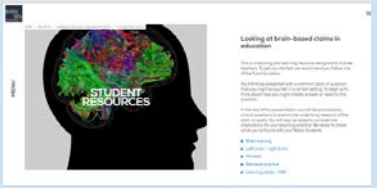
https://www.bathspa.ac.uk/projects/learning-sciences-in-teacher-education/



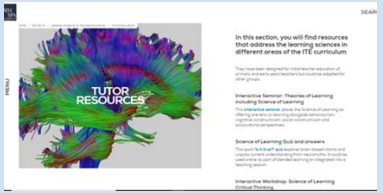
[How shall we address the Learning Sciences in Initial Teacher Education?]



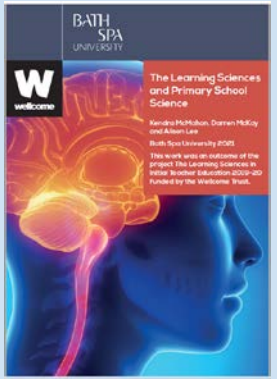
[The Learning Sciences and the Core Content Framework]



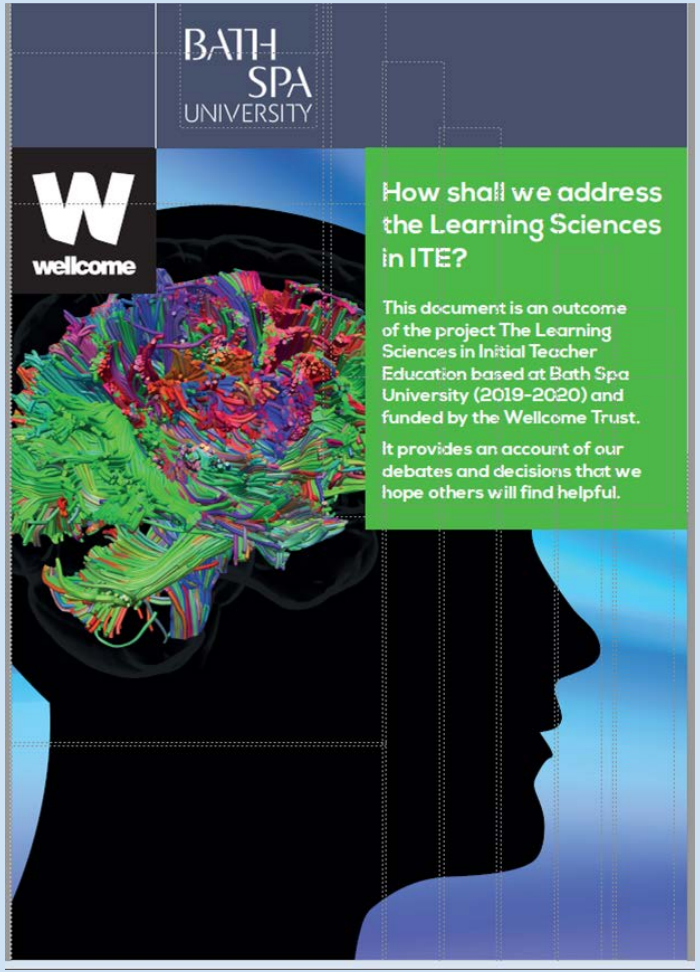
[Student Resources]



[Tutor Resources]



[The Learning Sciences and Primary Science]



[supporting-itt-core-content-framework]

How shall we address the Learning Sciences in Initial Teacher Education?

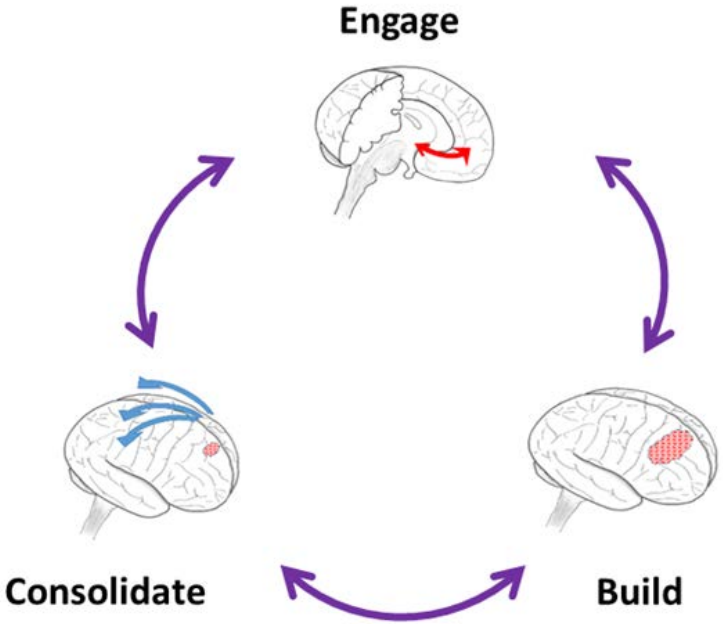
- Be open to the possibilities of new insights from scientific accounts of learning: they offer new ideas and explanations to consider alongside other educational perspectives
- Take a broad view of the Learning Sciences - not just cognitive psychology - including educational neuroscience!
- Maintain a critical viewpoint - neuroscience can be misused as the final word to settle complex debates (Gruber, 2017)
- It should support teacher judgment and professionalism

Introducing SoL to PGCE (Secondary) at University of Bristol

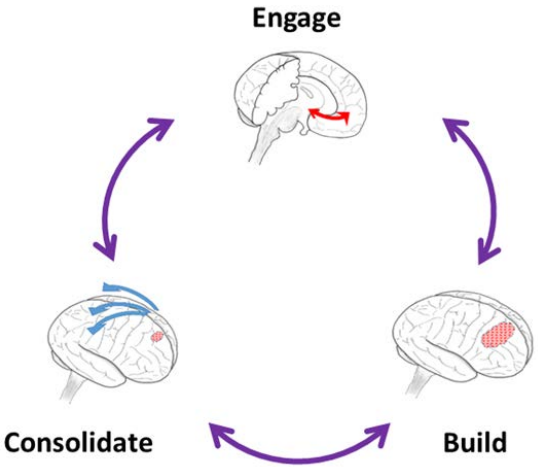
(at UoB since 2017)

1. Assembled a team
2. Interrelated perspectives
3. Developed content
4. Planned delivery
5. Monitoring and assuring

Holistic understanding of classroom learning
- a toolkit for understanding aligned with CCF/ECF concepts



scienceoflearning-ebc.org



ENGAGE	E1. **Every brain is unique** and students differ in how well they can control their attention and what engages their attention.
	E2. An "**approach response**" in the brain can be stimulated by rewards such as praise and tokens acknowledging achievement, novelty, provision of choice and sharing attention.
	E3. **Fearfulness** can avert attention, and anxiety reduces the brain's ability to process information.
	E4. The brain is "**plastic**", and both teacher and student have an important role constructing its function, connectivity and structure.
BUILD	B1. To be meaningful and lasting, new knowledge must build on **prior knowledge**. A child's developing brain requires more support in making connections to prior knowledge.
	B2. Clear, concise instruction and minimizing distraction can aid communication and student understanding of new knowledge by reducing unnecessary load on **working memory**.
	B3. Our Mirror Neuron System helps us read each other's minds. We communicate understanding and emotions (e.g. confidence and enthusiasm) both consciously and **unconsciously**.
CONSOLIDATE	C1. **Rehearsal** of freshly-learnt knowledge and understanding causes it to become automatically accessible. This frees up the brain's limited capacity to pay conscious attention - ready for further learning.
	C2. **Applying knowledge** (especially in new situations), linking between different representations of it, enacting, discussing or expressing it in new forms – all help us store knowledge in different ways – making it easier to recall and use it.
	C3. A good night's **sleep** helps us attend to today's learning but also makes yesterday's learning more permanent.

SoL concepts selected for use in explaining evidence-based practices

Evidence-based established good practices

SoL concepts

			Principles of instruction (Rosenshine, 2010)									Principles for Emotion and Learning (Pekrun, 2014)								
			1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
			Daily review	Present new material in small steps	Ask questions	Provide models	Guide student practice	Check for student understanding	Obtain a high success rate	Provide scaffolds for difficult tasks	Independent practice	Weekly and monthly review	Understanding emotions	Individual and cultural differences	Positive emotions and learning	Negative emotions and learning	Self-confidence, task values and emotions	Emotion regulation	Classroom instruction and teacher emotions	Goal structures and achievement	Test-taking and feedback	Families, peers and school reform
Scientific concepts explaining underlying processes	ENGAGE	Individual differences in engagement							X				X	X	X	X	X	X		X		X
		Approach response			X				X				X		X		X		X	X	X	X
		Fearfulness and anxiety		X		X	X	X	X	X			X	X		X	X	X	X	X	X	X
		Understanding plasticity											X		X	X	X	X		X	X	X
	BUILD	Prior knowledge	X	X	X			X				X										
		Connection-making brain development	X	X	X	X	X			X												
		Multimodal/multisensory representation					X			X												
		Unconscious communication, MNS													X	X			X			X
	CONSOLIDATE	Practice, working memory, automatization	X	X	X			X		X	X	X										
		Variable representation of knowledge in brain	X		X			X			X	X										
		Sleep	X								X	X										

Table 1. Mapping of core scientific concepts (identified in main text) to teaching principles (as identified in Pekrun, 2014; Rosenshine, 2010)

How Pupils Learn (Standard 2 – 'Promote good progress')

Learn that…	Learn how to…
1. Learning involves a lasting change in pupils' capabilities or understanding. 2. Prior knowledge plays an important role in how pupils learn; committing some key facts to their long-term memory is likely to help pupils learn more complex ideas. 3. An important factor in learning is memory, which can be thought of as comprising two elements: working memory and long-term memory. 4. Working memory is where information that is being actively processed is held, but its capacity is limited and can be overloaded. 5. Long-term memory can be considered as a store of knowledge that changes as pupils learn by integrating new ideas with existing knowledge. 6. Where prior knowledge is weak, pupils are more likely to develop misconceptions, particularly if new ideas are introduced too quickly.	**Avoid overloading working memory, by:** • *Receiving clear, consistent and effective mentoring in how to take into account pupils' prior knowledge when planning how much new information to introduce.* • *Discussing and analysing with expert colleagues how to reduce distractions that take attention away from what is being taught (e.g. keeping the complexity of a task to a minimum, so that attention is focused on the content).* **And - following expert input - by taking opportunities to practise, receive feedback and improve at:** • *Breaking complex material into smaller steps (e.g. using partially completed examples to focus pupils on the specific steps).* **Build on pupils' prior knowledge, by:** • *Discussing and analysing with expert colleagues how to sequence lessons so that pupils secure foundational knowledge before encountering more complex content.* • *Discussing and analysing with expert colleagues how to identify possible misconceptions and plan how to prevent these forming.* **And - following expert input - by taking opportunities to practise, receive feedback and improve at:** • *Encouraging pupils to share emerging understanding and points of confusion so that misconceptions can be addressed.*

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How do "take into account"?

What distracts? e.g. text and talk on a slide?

Why do this? How small are steps?

What learning processes can be impacted by sequence?

And for what other reasons?

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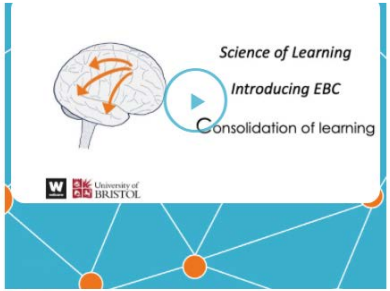
accessible. This frees up the brain's limited capacity to pay conscious attention – ready for further learning.

C2 **Applying knowledge** (especially in new situations), linking between different representations of it, enacting, discussing or expressing it in new forms – all help us store knowledge in different ways – making it easier to recall and use it.

C3 A good night's **sleep** helps us attend to today's learning but also makes yesterday's learning more permanent.



Relate this to:

MENTORING TEACHERS USING ENGAGE BUILD CONSOLIDATE

Talking about Learning during Mentoring

- Debriefing Clip 1 Lesson Description
- Debriefing Clip 2 Lesson Description

Talking about Engagement for Learning

Talking about Building Knowledge and Understanding

Talking about Consolidation of Learning

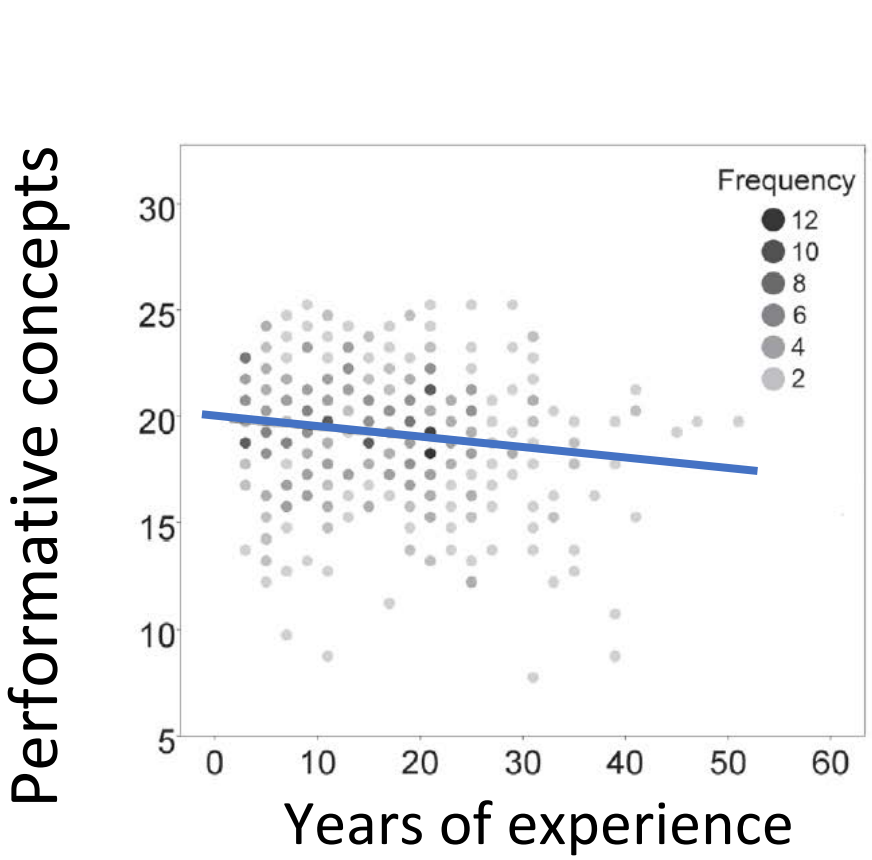
Effect of Professional Development about SoL (Educational Neuroscience) on value attributed to performative beliefs

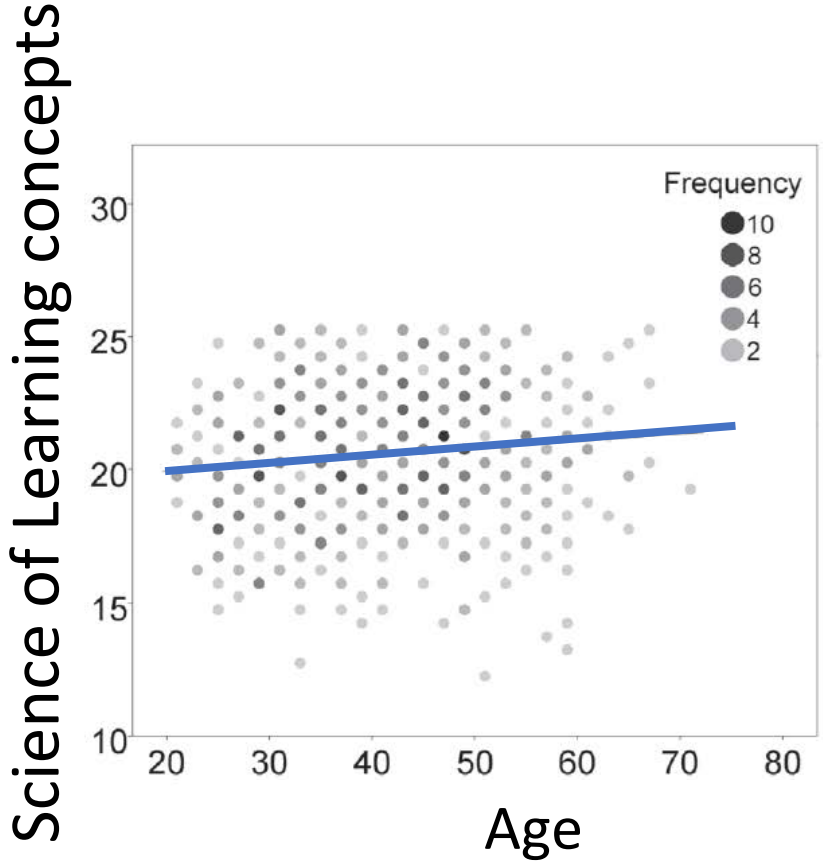
- Performative concept: “A lesson must have a beginning, a middle and an end” – offers little insight (but sounds/looks good)
- Scientific concept: "Children’s brain circuitry for connecting new information to prior knowledge is still developing” – no prescription (but offers insight)

- 585 teachers asked how valuable concepts were before and after receiving 90-min CPD session on EBC.

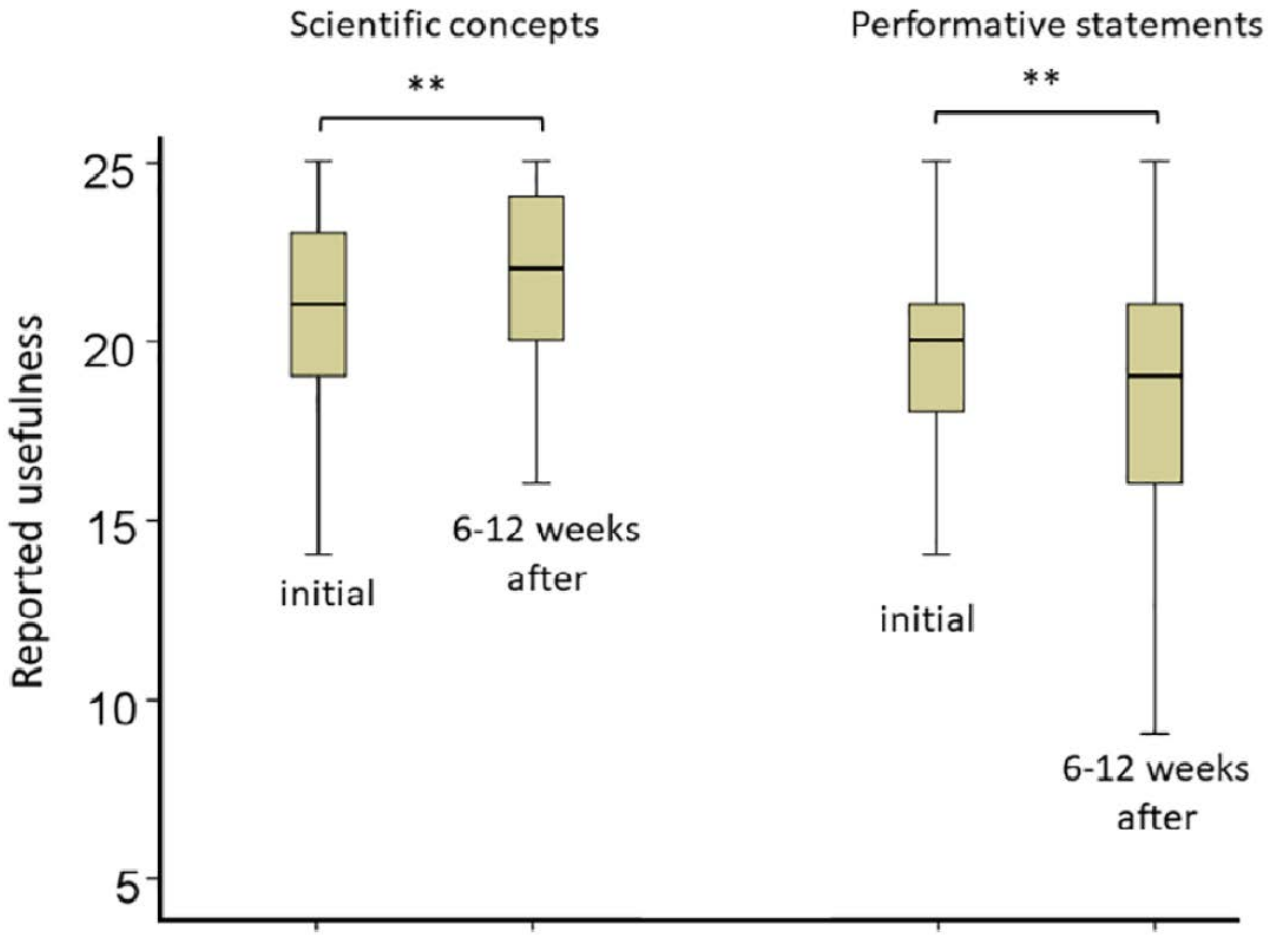
Value placed on performative ideas decreases with experience

Value placed on Science of Learning increases with age





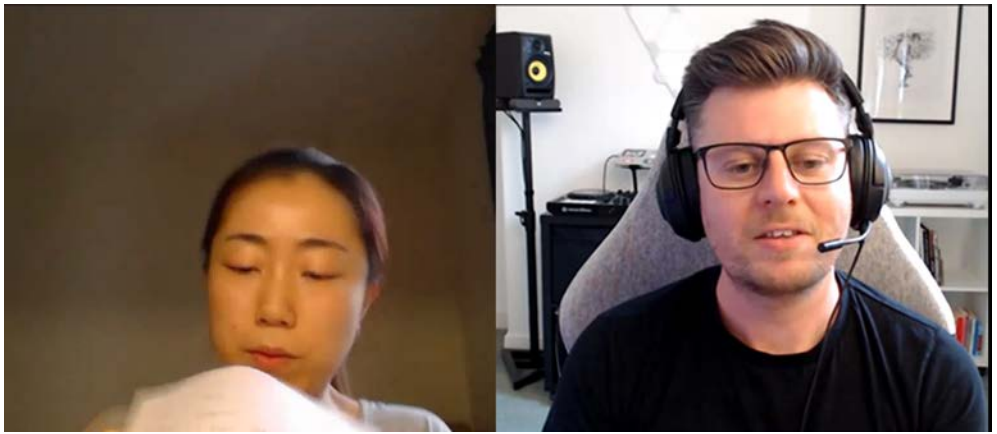
Just 90 minutes CPD increased SoL + decreased performativity ratings 6 weeks later



Howard-Jones et al. (2020). Professional Development on the Science of Learning and teachers' Performative Thinking—A Pilot Study. Mind, Brain and Education, 14(3), 267-278.

A Science of Teaching? Online micro-teaching…

- Adults with a range of teaching experiences teach each other an uncommon language for 15 minutes
- “Teacher” has 10 minutes to prepare, “student” does pre/post test).



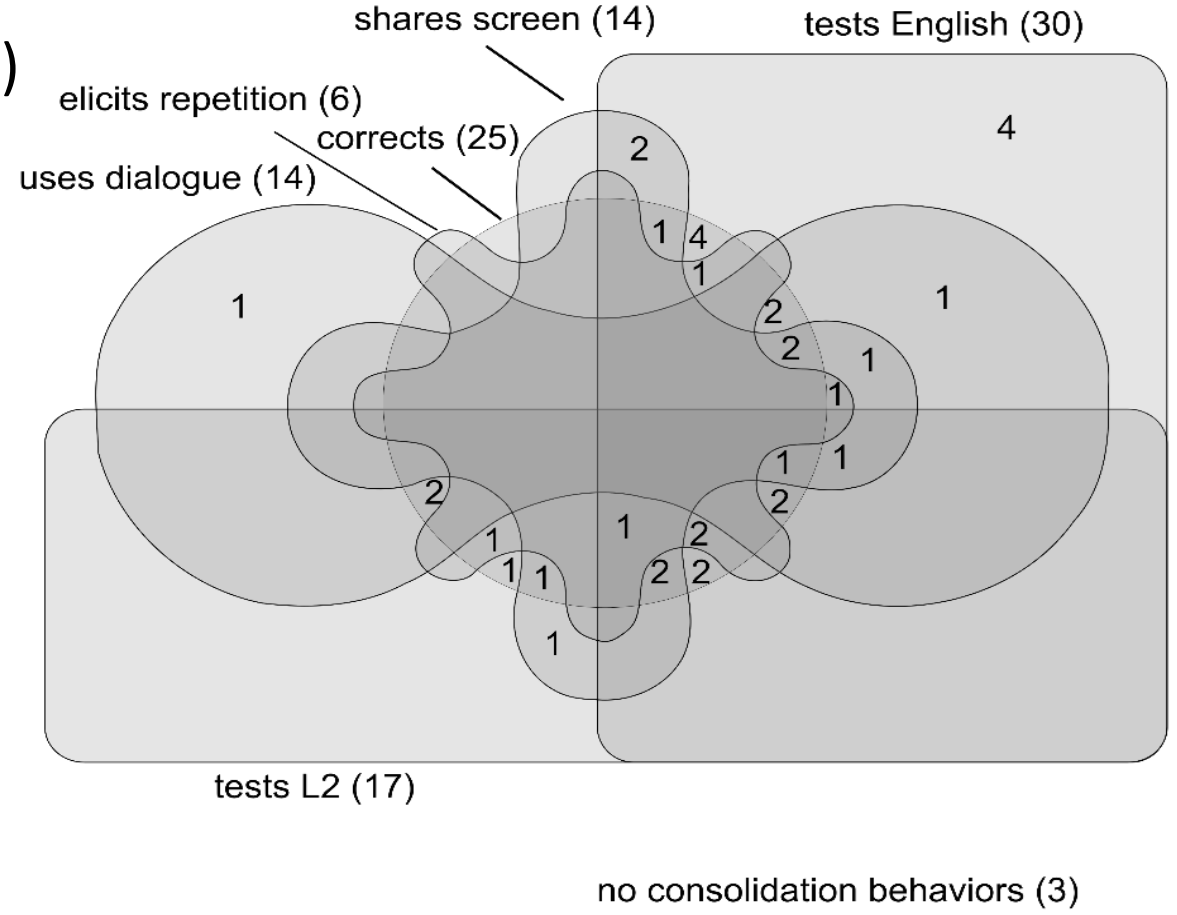
- Build and Consolidate teaching behaviours predict learning
- When “engage” teaching behaviour measured by counting praise words, this *negatively* predicts learning (so context very important)
- Experience as language teacher does not impact outcomes
- Qualitative analysis shows massive diversity in teaching approach

Diversity in consolidation teaching behaviours (N=40)

Sets are teachers exhibiting 1+ instance of a subcategory of teaching behaviour.

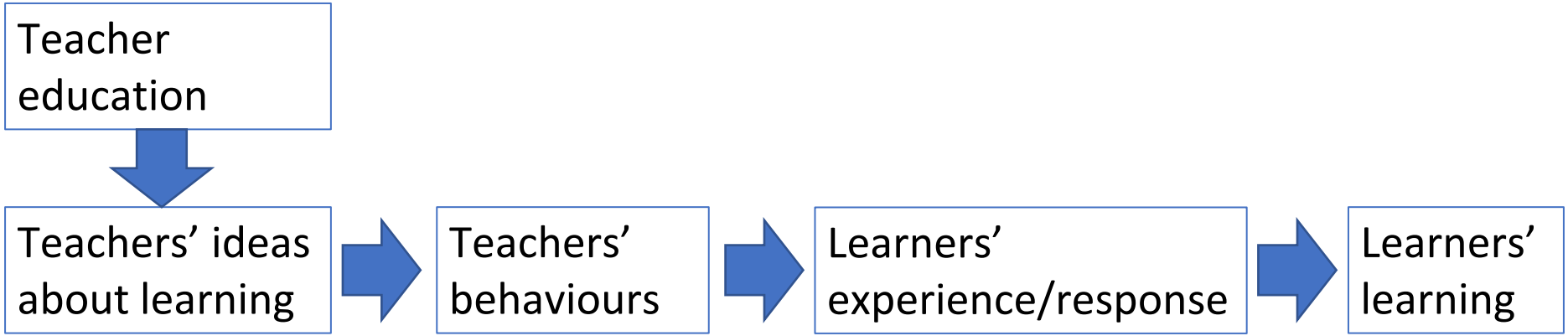
The Venn diagram of the unions of these sets shows how teachers combine behaviours.

Most of the numbers in the unions are either a 1 or a 2. So most teachers display a combination of consolidations behaviours shared by no more than one other teacher.



- This experimental pilot discourages notions that science can offer a simple prescriptive list of effective teaching behaviors.

- Rather than produce more decontextualised interventions with narrow objectives, experimental study can use contextualised frameworks that reveal complexity and help us understand/test some fundamental **but, so far, chiefly hypothetical** relationships:



1. To what extent do you consider evidence-based “science of learning” to be an
essential part of Initial and Early Career Teacher Education and Development?

2. How would you prioritise the ideas / understanding from ‘science of learning’
for inclusion (exclusion?) at each stage of Initial and Early Career Teacher
Education and Development?