

# How do Science of Learning (SoL) research findings influence practitioners' teaching effectiveness?

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# SoL becoming part of UK legal requirements for teachers

## How Pupils Learn (Standard 2 – ‘Promote good progress’)

### Learn that...

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.

### Learn how to...

#### **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.*

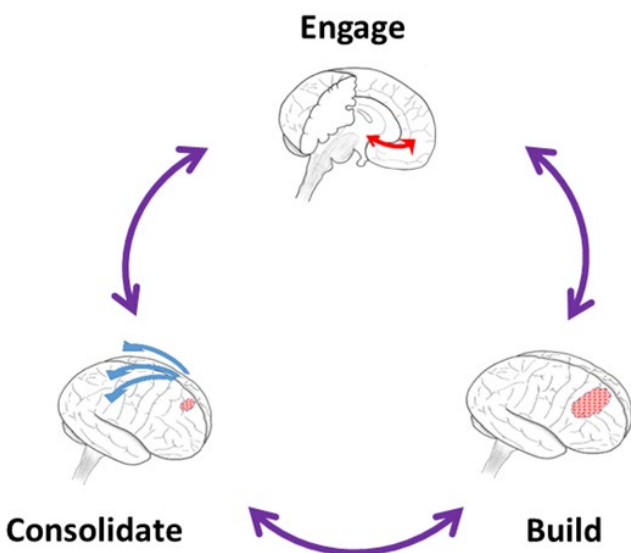
# Introducing SoL to Teacher Training at University of Bristol

(in 2017)



1. Assemble a team
2. Interrelate perspectives
3. Develop content
4. Plan delivery
5. Monitor and assure

# We provide a “toolkit” for understanding classroom practice



<b>ENGAGE</b>	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.
<b>BUILD</b>	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.
<b>CONSOLIDATE</b>	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 their explanatory value for practice

## 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
Scientific concepts explaining underlying processes	ENGAGE	Individual differences in engagement						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
		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											
	CONSOLID	Unconscious communication, MNS													X	X		X			X
		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									

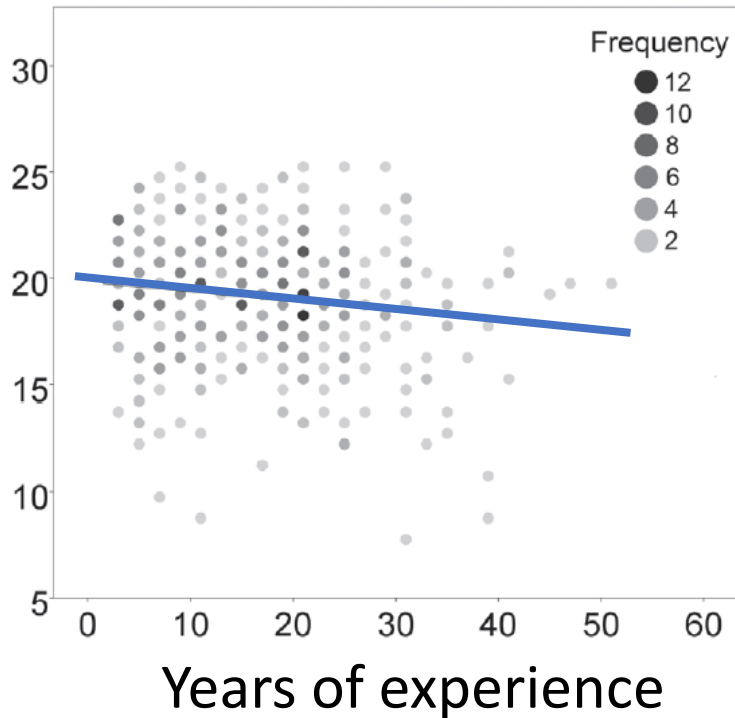
Table 1. Mapping of core scientific concepts (identified in main text) to teaching principles (as identified in Pekrun, 2014; Rosenshine, 2010)

# SoL impacts value of scientific vs. performative beliefs

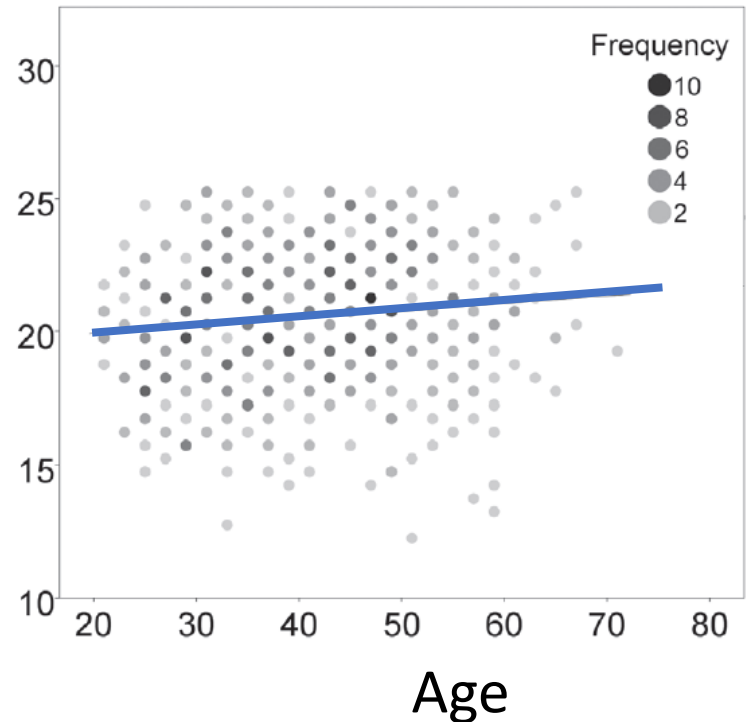
- Performative concept: “*A lesson must have a beginning, a middle and an end*” – offers little insight but sounds/looks good
- Scientific concept: “*Children’s brain circuitry for connecting new information to prior knowledge is still developing*” – not prescriptive but offers insight
- 585 teachers asked how valuable concepts were before and after receiving 90-min CPD session on EBC.

# Teacher beliefs change with age and experience

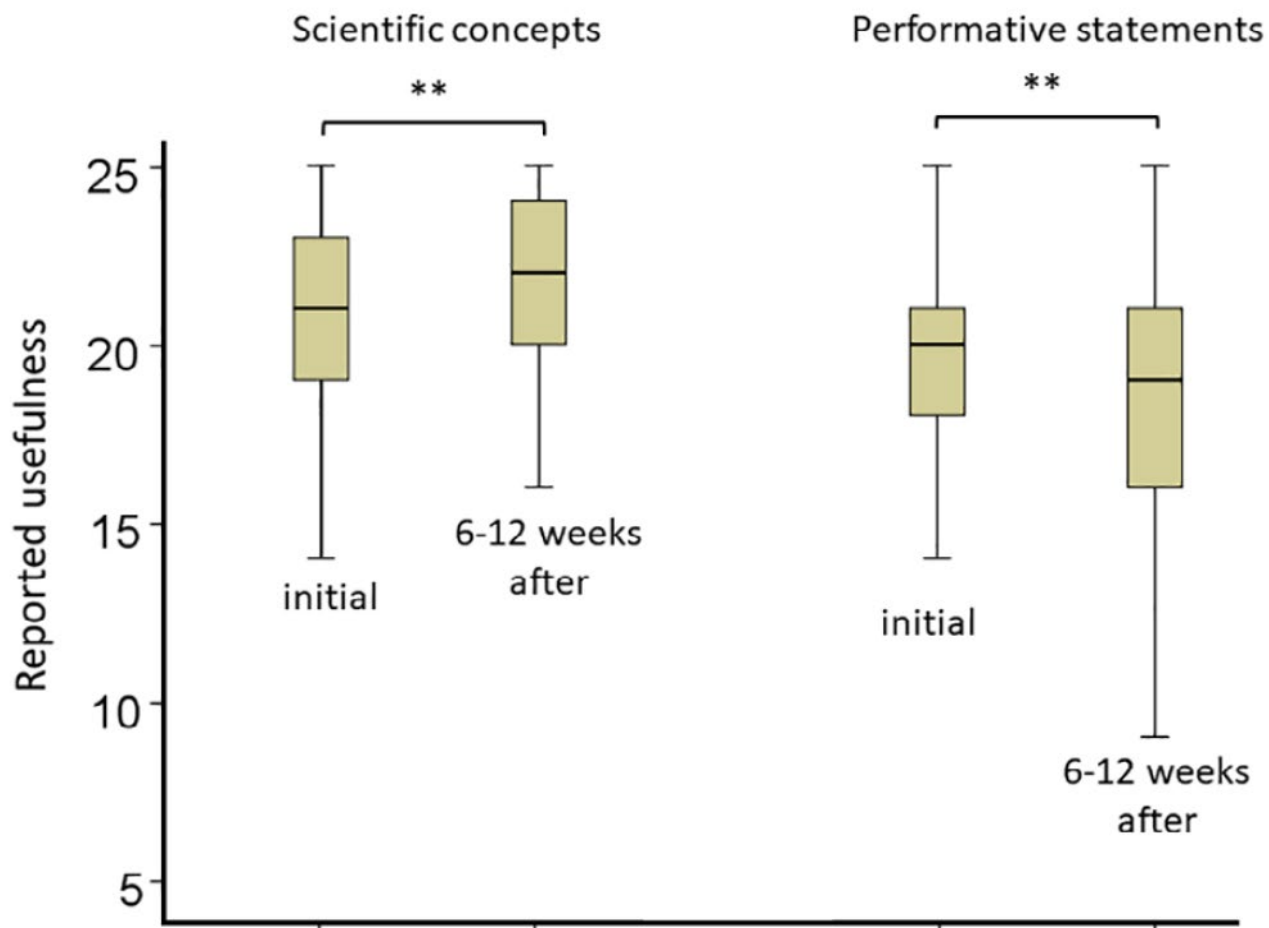
Performative concepts



Science of Learning concepts



# 90 minutes Professional Development 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), 26-278.



# BUT: When does teacher professional development lead to improved student learning?



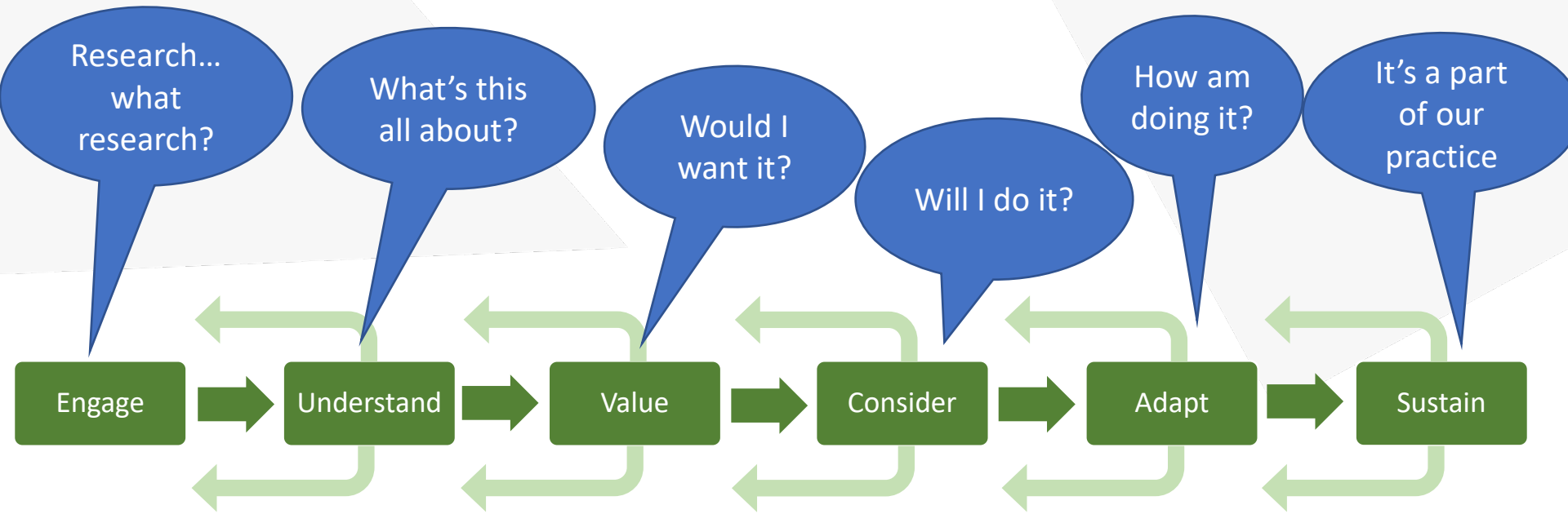
(Small effect – and not even statistically significant at EY or primary – Sims et al. 2021)

# A crucial knowledge GAP for SoL professional development

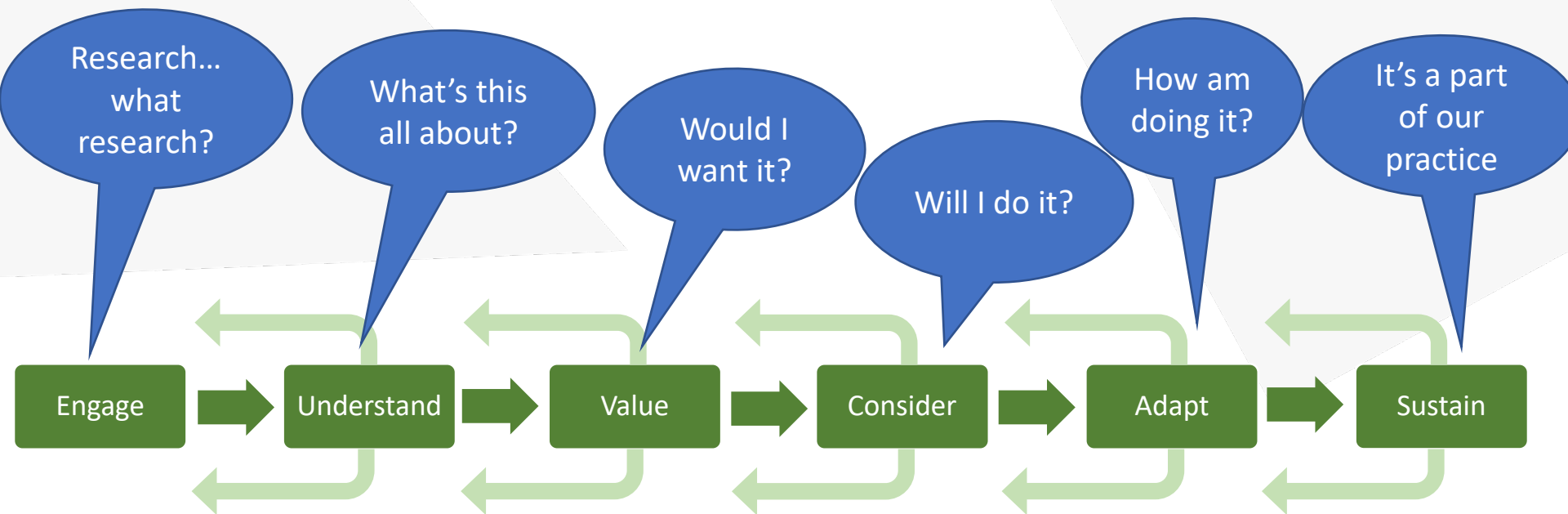
Little EVIDENCE – Nothing experimental about:

- How teachers think about learning, and its relation to their teaching & student learning
- How SoL concepts impact their thinking, practice, effectiveness

# The journey from research to practice



# The journey from research to practice



Aligned with what educators care about?

Inclusion of educators needs and knowledge?

Congruent with educator/school values?

Tested in and user-friendly for context?

Adaptations guided by professional development, resources and school system?

Impact evidence for school and teachers?

Platforms and brokerage?

Expression of balance, magnitudes, uncertainty?

Associated with successful professionals?

Personal resources to do this?

Adaptations monitored?

Long-term networks?

Novel, shared, with some autonomy?

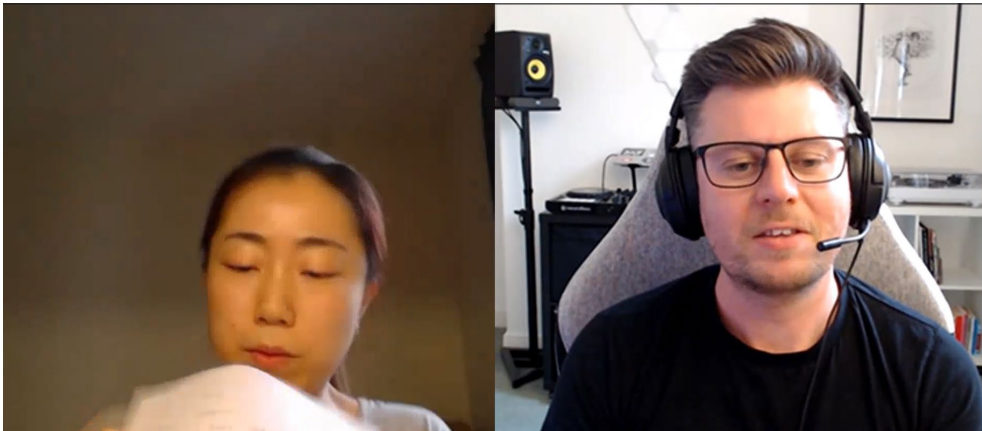
Aligned with professional identity?

Is there peer support?

School leadership support?

# A Science of Teaching? Online micro-teaching...

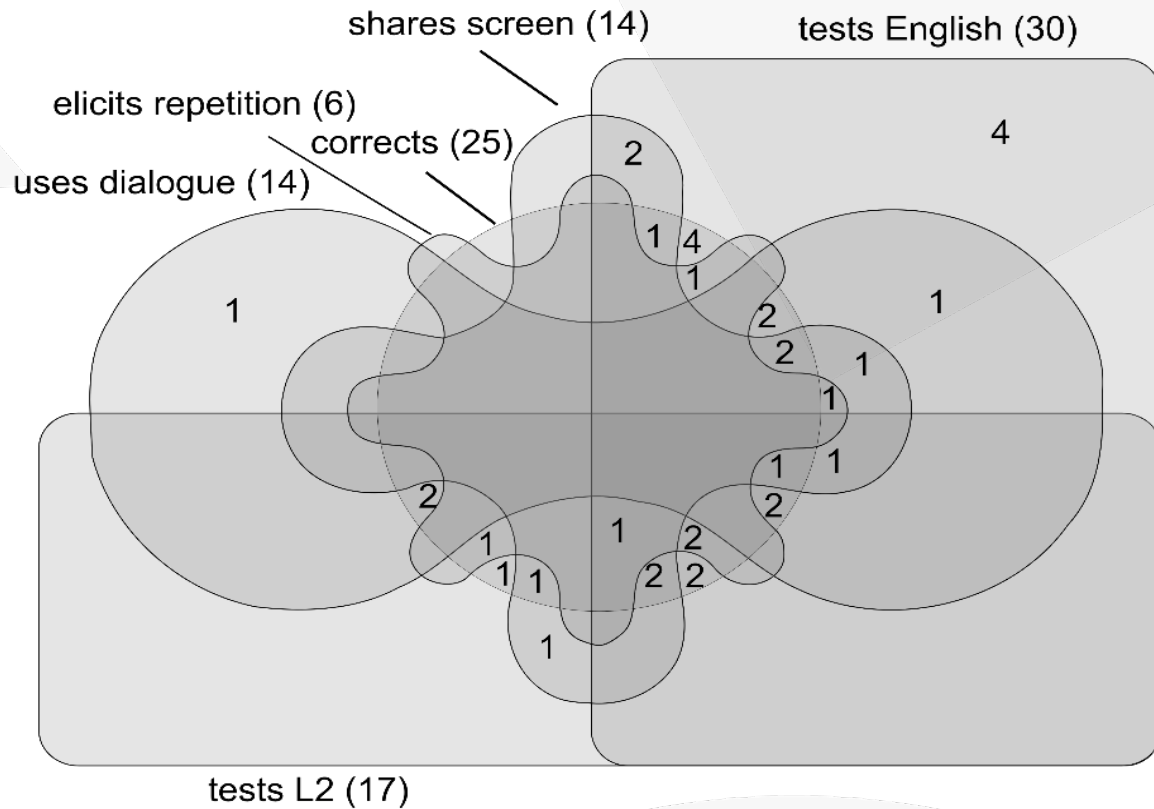
- Adults with a range of teaching experiences teach each other an uncommon (L2) language for 15 minutes
- “Teacher” has 10 minutes to prepare, “student” does pre/post test).
- Build and Consolidate teaching behaviours predict learning
- When “engage” teaching behaviour measured by counting praise words, this *negatively* predicts learning (so context very important)
- Experience as language teacher does not impact learning outcomes
- Qualitative analysis shows massive diversity in teaching approach
- **Now studying impact of SoL on teacher thinking, practice, effectiveness**



# Diversity in consolidation teaching behaviours (N=40)

*Numbers in brackets:* Sets of teachers exhibiting a teaching behaviour

*Numbers not in brackets:* Intersections showing number of teachers sharing practices.



no consolidation behaviors (3)

# Summary

- Teachers value SoL research findings for providing insight into their own practices
- We know little about the “journey” - from teachers grasping research findings to enhancing their students’ learning – *except that it doesn’t often happen!*
- Experimental investigation of teaching (“A Science of Teaching”) should be the next important step for SoL