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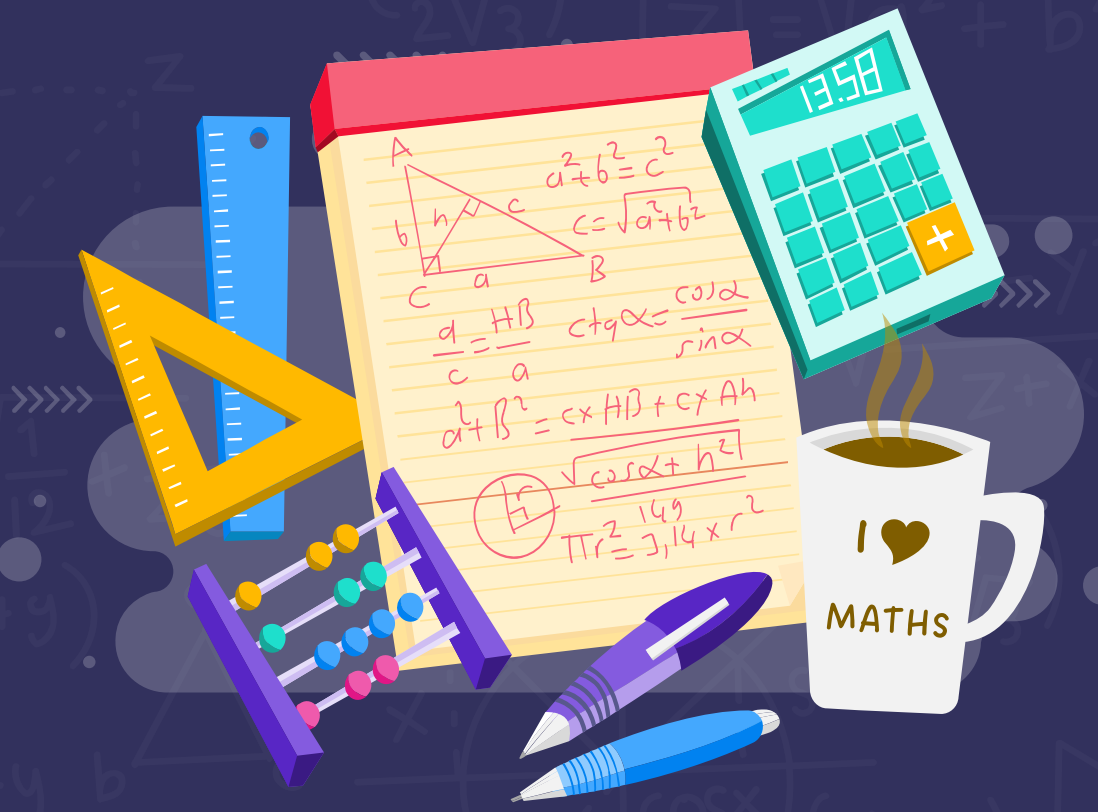
Practicality or Pedagogy?



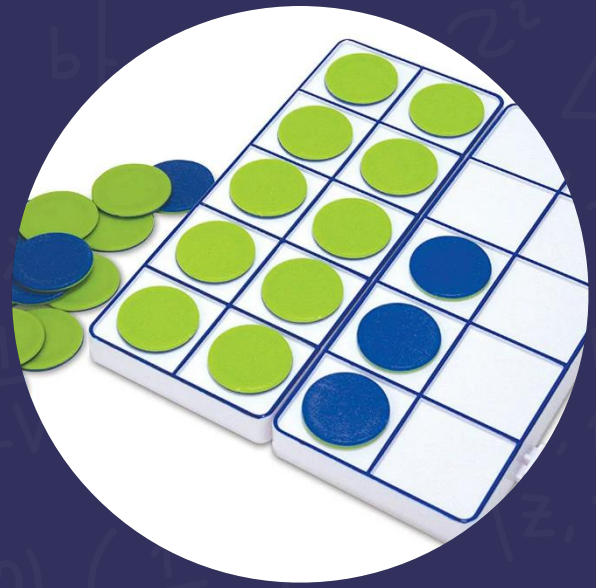
Exploring the rationale teachers give for using manipulatives in their classrooms

Simon Sheard
Senior Lecturer in Education
University of Sunderland

Programme Leader for Distance Learning (International) PGCE

- Over 60 countries
- Community, State and International Schools
- Primary and Secondary streams
- Mirrors most aspects of our on-campus ITT provision
- iQTS

How do primary mathematics teachers' perceptions of Teaching for Mastery (TfM) inform their choices when selecting and using manipulatives (concrete resources) within their lessons?



MANIPULATIVES

Choice overload?

Contribute to my Shape Up discussion

All posts are anonymous

Topic 1: Do you have a preferred manipulative?

[Maths] Mastery – are we all on the same page?

Duckworth et al. (2015)

Mastery in theory may be easier to define than in practice

National Association of Mathematics Advisors (2015)

We suggest that idea of the existence of a single definition is a myth.

Garry (2020)

The first thing to bear in mind about mastery is that it is a contested concept. There are fierce battles being waged (online and in person) about what mastery means, and about what does or does not constitute a mastery approach.

TENSIONS

DEFINTIONS

See previous slide

KNOWLEDGE

"we have no problem [in the UK] with allowing a great number of teachers with little deep subject knowledge to teach maths to primary-age pupils" (Garry, 2020, p. 17)

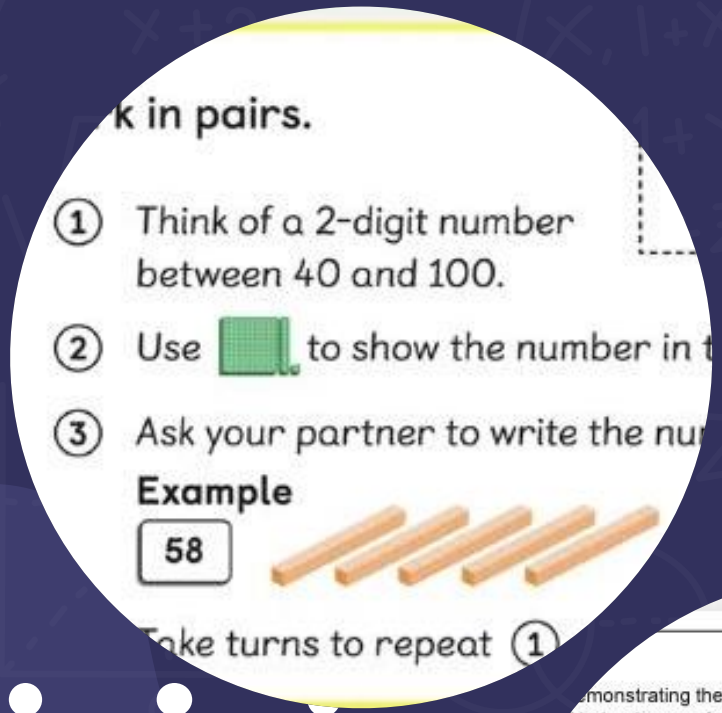
EXPORT

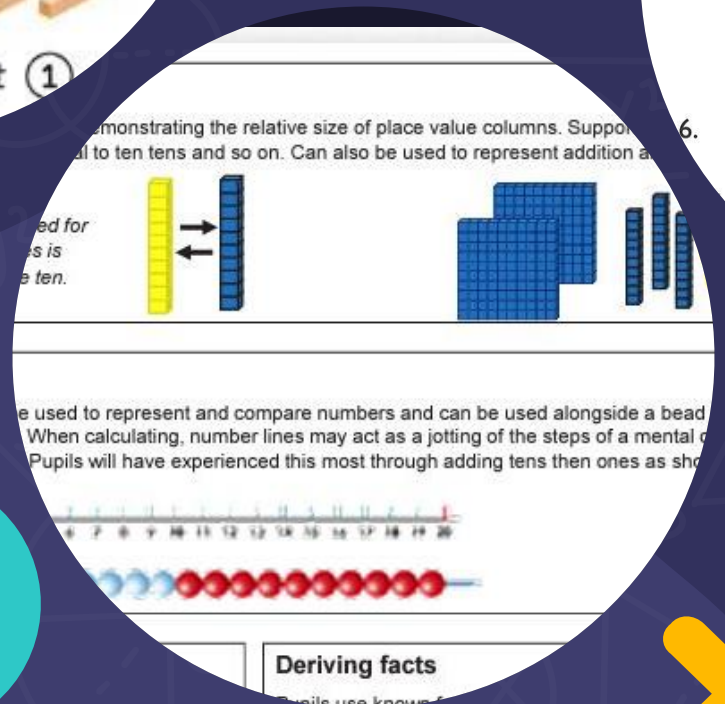
"despite difficulties in even defining the concept of an 'East Asian teaching method', policymakers continue to believe this to be a key reason why mathematics achievement is so much greater in the East than the West" (Jerrim & Vignoles, 2015, p.5)

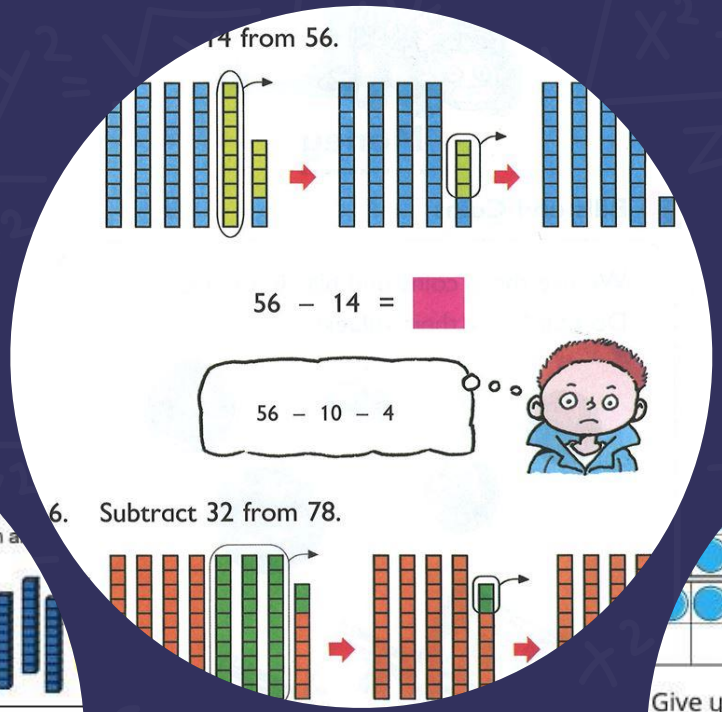
IMPLEMENTATION

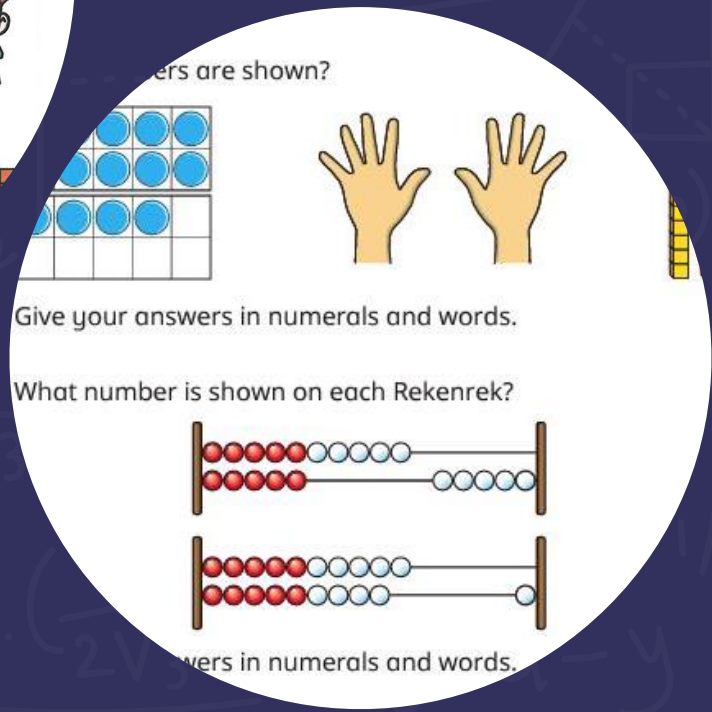
the disconnection between educational recommendations and teachers' beliefs (Golafshani, 2013)

Supporting resources





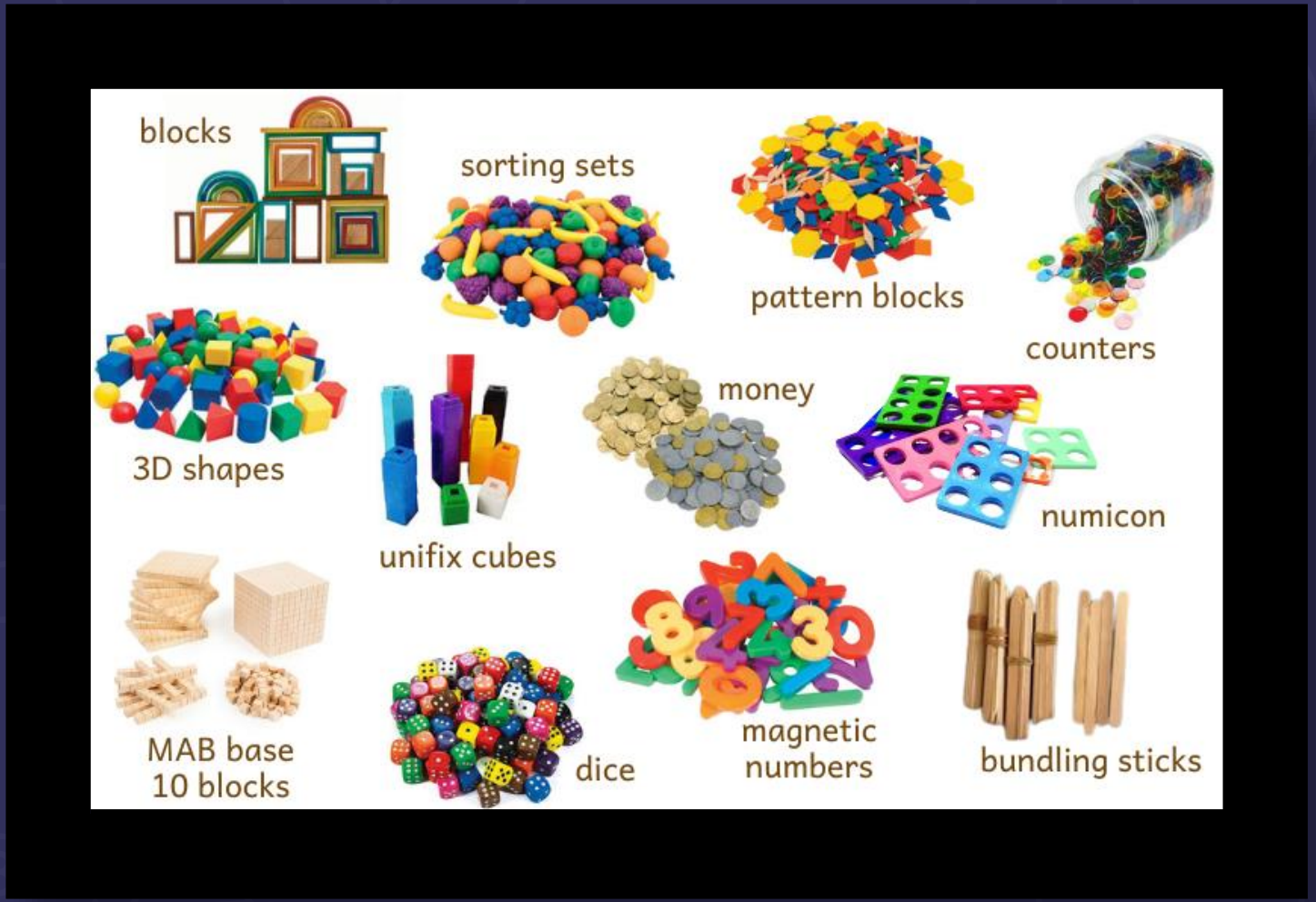




- Carbonneau, *Marley & Selig* (2013) highlight the importance of effective instructional strategy in the use of manipulatives to improve achievement.

- Success is dependent upon:
  - ✓ The level of instructional guidance
  - ✓ The type of manipulative
  - ✓ The age of the learners
  - ✓ The learning environment

- 'Manipulatives are not magic… [they] are not, of themselves, carriers of meaning or insight' (Moyer, 2001, p. 176).

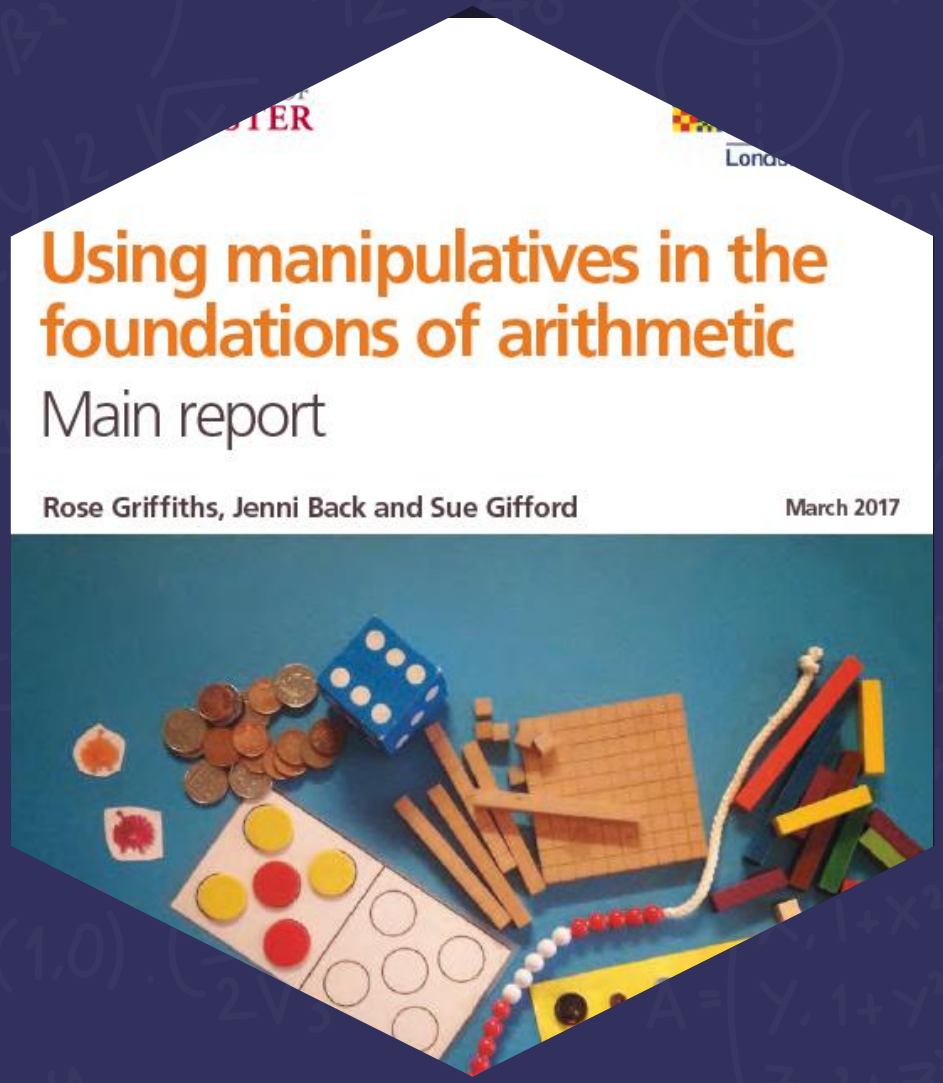


Carbonneau, K.J., Marley, S.C. and Selig, J.P. (2013). A meta-analysis of the efficacy of teaching mathematics with concrete manipulatives. Journal of Educational Psychology, 105(2), pp.380–400.

Manipulatives work because they:

- ✓ Help children make sense of arithmetic
- ✓ Help teachers see what children understand
- ✓ Increase children's engagement and enjoyment
- ✓ Develop visual images and understanding
- ✓ Help children to work together and share ideas
- ✓ Are tools to help children solve problems; investigate patterns and relationships; demonstrate and explain results and reasoning
- ✓ Provide a bridge to abstract thinking

(Griffiths, Back and Gifford, 2017, p. 3)



The literature tells us:

PEDAGOGICAL CONSIDERATIONS:

1. a clear rationale for manipulative use in the context of the mathematical content being delivered
2. the appropriate level of guidance is provided
3. allow sufficient time
4. the perceptual richness or blandness of the manipulative is considered
5. manipulative use is linked to the abstract ideas being represented

PRACTICAL CONSIDERATIONS:

6. practical organisation

1. **a clear rationale** for manipulative use in the context of the mathematical content being delivered

there is a clear rationale for using a particular manipulative to teach a specific mathematical concept (Education Endowment Foundation, 2020)

teachers should consider carefully how the manipulative will be used to build on existing understanding

The planning of any lesson and the choice of appropriate manipulative materials must begin with a learning objective clearly in mind (Ross and Kurtz, 1993)

2. the appropriate level of **guidance** is provided

Low level

- students who reach proficiency with limited or no instructional guidance develop greater conceptual understanding
- control of decisions relating to mathematical tools should not be claimed solely as the teacher's domain

High level

- allows students to access explicit opportunities to select pertinent information
- without explicit instruction, children may not move objects in a manner that appropriately represents the mathematics concept being taught
- benefit lower-achieving learners as the introduction of additional learning materials increases the cognitive demands experienced by these learners

or 'transitioning guidance'?

3. allow sufficient **time**

The fifth variable in Bloom's *mastery of learning* strategies

extended use of manipulatives has a positive effect on measures of retention (Sowell, 1989)

'use a [specific] manipulative consistently over a long period of time' (Laski et al., 2015, p. 2)

young children in particular need time to make the relation between the concrete materials and the abstract concepts they represent

lessons which support the deepest levels of thinking and reasoning give students plenty of time to work with the manipulatives (Stein and Bovalino, 2001)

4. the **perceptual richness** or blandness of the manipulative is considered

bland

rich

- Dual representation: rich manipulatives elicit ideas irrelevant to the mathematics
- 'materials that look like real-world objects can be downright distracting to students and can draw their attention to superficial characteristics or irrelevant associations' (Brown, McNeil and Glenberg, 2009, p. 161)

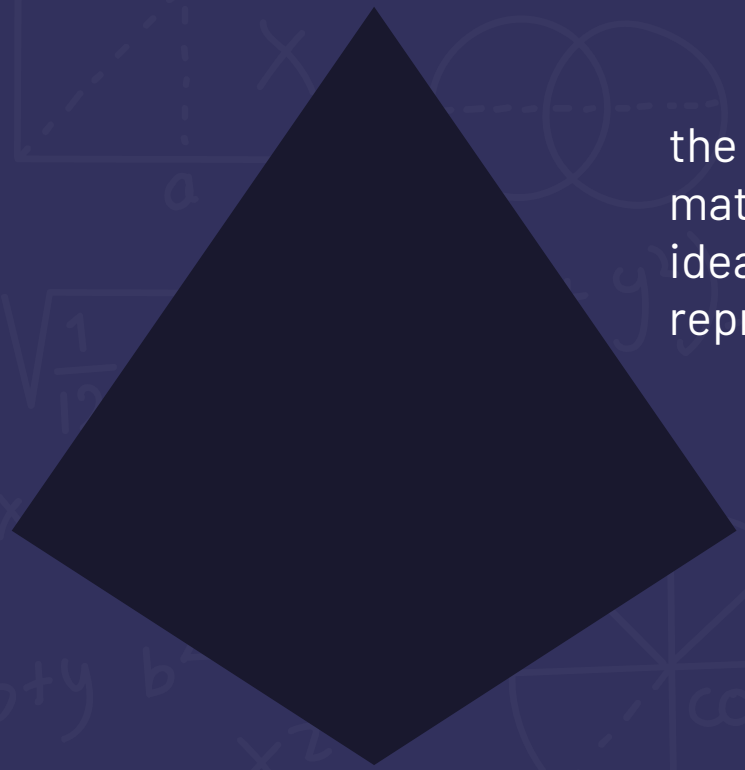
- results on transfer of learning, an outcome that requires greater conceptual understanding of the mathematics concepts, indicated that perceptually rich manipulatives may enhance student learning' (Carbonneau, Marley and Selig, 2013, p. 395)

'results tend to be in favour of learning with the use of perceptually bland manipulatives' (Carbonneau, Min Wong and Borysenko, 2020, p. 2)

5. manipulative use is linked to the **abstract ideas** being represented

Linking manipulatives to abstract symbols is a key pedagogic principle for their effective use (Griffiths, Back and Gifford, 2017b)

pupils must understand the links between the manipulatives and the mathematical ideas they represent (Education Endowment Foundation, 2017)



the mathematical relationships must be imposed on the materials as 'the student's own internal representation of ideas must somehow connect with the external representation or manipulative' (Moyer, 2001, p. 192)

'all symbolic objects have a dual nature; they are simultaneously objects in their own right and representations of something else. To use a symbolic object effectively, one must focus more on what the symbol is intended to represent and less on its physical properties' (Uttal *et al.*, 2009, p. 156)

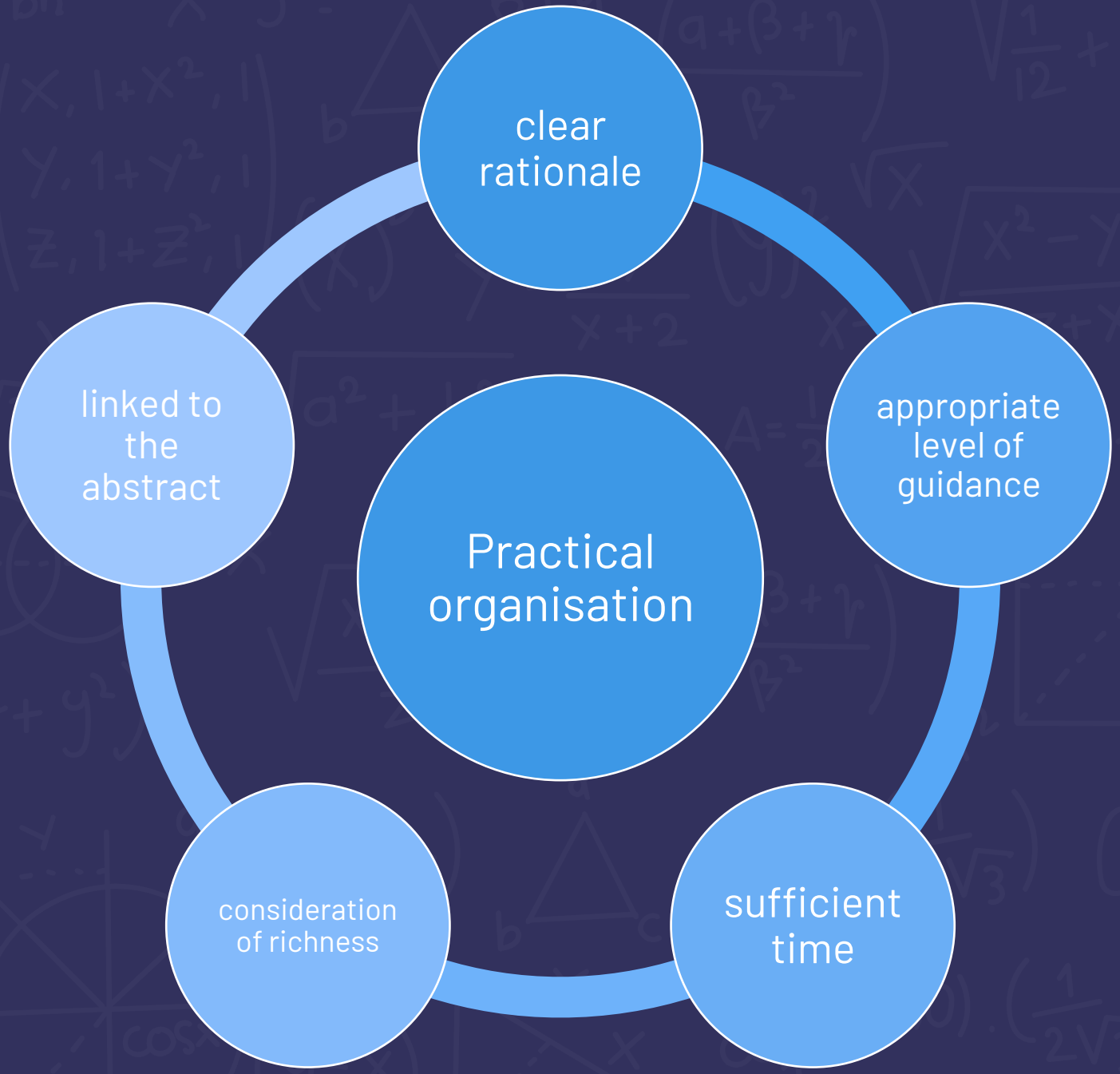
6. practical **organisation**

‘Good lessons using manipulatives do not just happen. They are the product of much advance thought and preparation’ (Stein and Bovalino, 2001, p. 359)

the effective use of manipulatives depends on the adequate preparation of the students and the materials (Ross and Kurtz, 1993)

when the structure of the learning environment fails to help children find the underlying concepts or processes, the use of concrete materials is ineffective at best (Brown, McNeil and Glenberg, 2009)

rehearsing with the manipulatives to pre-empt any misconceptions (Stein and Bovalino, 2001)


clear rationale
appropriate level of guidance
sufficient time
consideration of richness
linked to the abstract
Practical organisation

Contribute to my Shape Up discussion

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Topic 2: Do you encounter any barriers when planning for or using manipulatives?

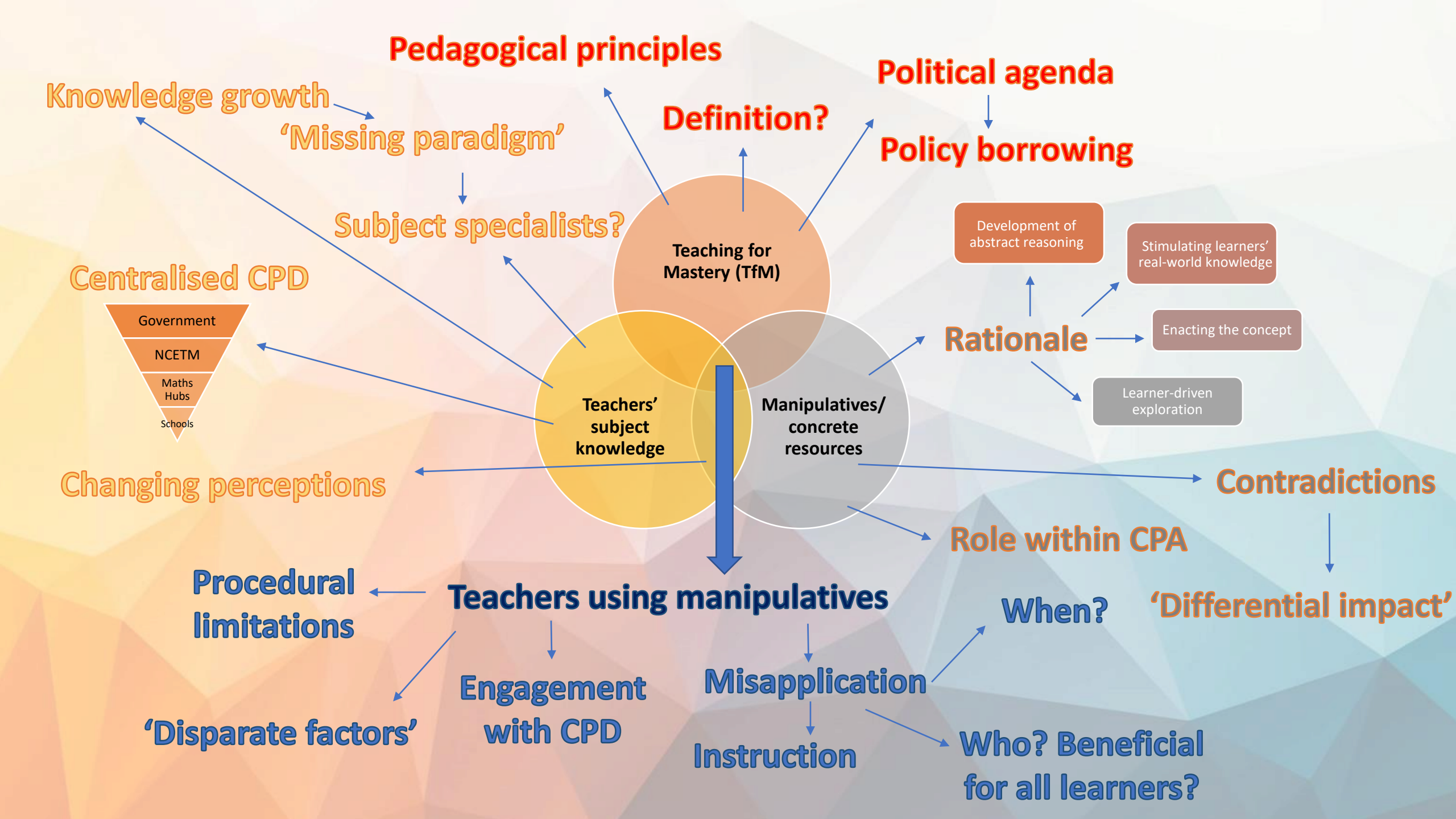
MY RESEARCH

AIMS TO:

- document which manipulatives are used in primary classrooms
- record teachers' rationale for their selection and deployment
- establish the extent to which these decisions are informed by pedagogical content knowledge

IS IMPORTANT BECAUSE:

- The Education Endowment Foundation states that "practitioners' understanding of mathematical concepts needs to be strong in order to use manipulatives and representations effectively" (EEF, 2020, p.21)
- Whilst the Nuffield Report found that "teachers' choice of manipulatives was subject to disparate factors rather than pedagogical principles" (Griffiths, Back & Gifford, 2017)


Pedagogical principles
Knowledge growth
'Missing paradigm'
Definition?
Political agenda
Policy borrowing
Subject specialists?
Teaching for Mastery (TfM)
Development of abstract reasoning
Stimulating learners' real-world knowledge
Centralised CPD
Government
NCETM
Maths Hubs
Schools
Rationale
Enacting the concept
Learner-driven exploration
Teachers' subject knowledge
Manipulatives/ concrete resources
Changing perceptions
Contradictions
Role within CPA
Procedural limitations
Teachers using manipulatives
When?
'Differential impact'
Misapplication
Engagement with CPD
'Disparate factors'
Instruction
Who? Beneficial for all learners?

WHAT AM I FINDING?

POLITICAL LANDSCAPE

The ever-changing government agenda heavily influences the messages and CPD delivered by the Maths Hub and teacher rhetoric

VARIATION

Content Knowledge (CK) and Pedagogical Content Knowledge (PCK) is hugely variable, even within individual schools

PRACTICALITY BEFORE PEDAGOGY?

Manipulatives seem to be valued by their practicality, e.g. versatility, rather than their pedagogical merit for a certain task

more research is needed to inform teachers' choices about which, and how many, representations to use and when (EEF, 2017, p.11)

Practicality vs. Pedagogy

AVAILABILITY

What is available in my classroom? Are there sufficient sets for the groups/class? Is it cheap or expensive?

VERSATILITY

Can this manipulative be used for multiple applications? Or is it topic/task specific?

LOGISTICS

Is it 'easy' to administer and oversee?

Is it explained in the scheme of work?

CONTENT KNOWLEDGE

Do I understand how to use this manipulative?

PEDAGOGICAL CONTENT KNOWLEDGE

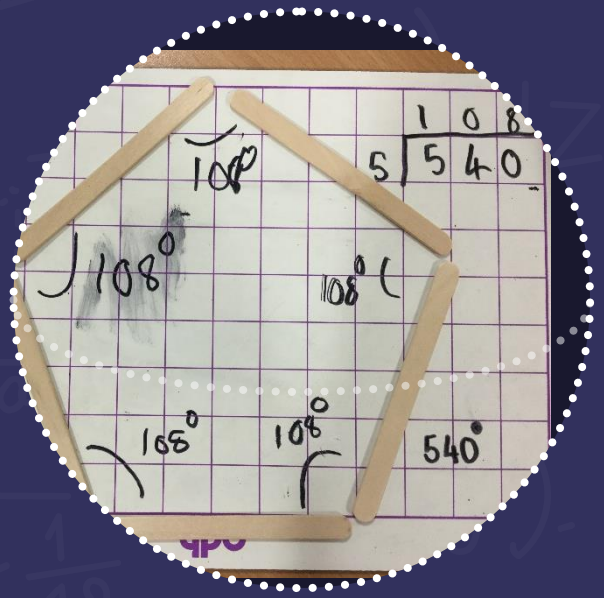
Am I confident instructing others how to use this manipulative for this task?

KNOWLEDGE CREATION

Is the manipulative driving the task?

Is the task driving the manipulative?

Why do I think it's important?



COLLABORATION

Sharing best practice with the many, not the few

CREATIVITY

Teaching mathematics in a way that inspires children

CONSISTENCY

Ensuring each child gets the same opportunities to enjoy mathematics

Topic 3: Your thoughts, opinions & questions

What does *maths mastery* look like in UK schools currently?

What are the opportunities and threats?

Where do you stand on 'practicality vs pedagogy'?

Where next for manipulatives in schools?

What advice would you give a teaching student or an Early Career Teacher regarding manipulatives?

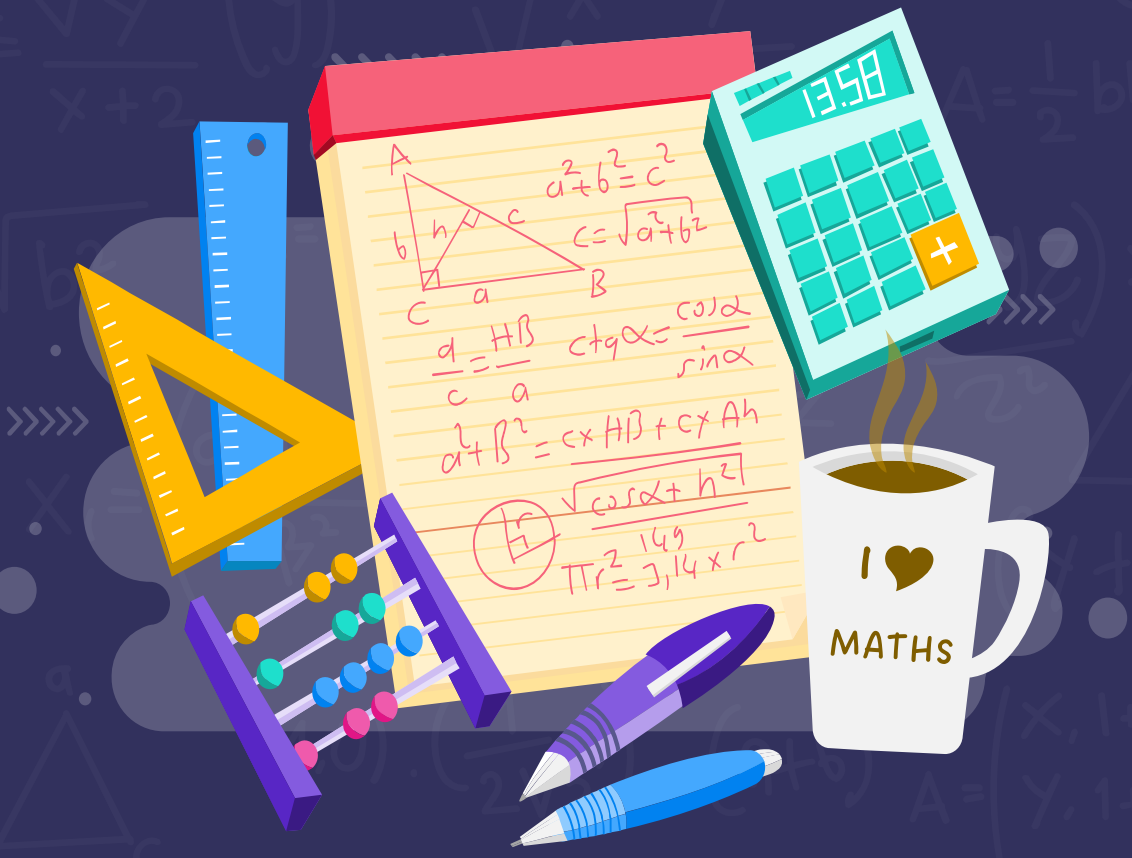
How could the curriculum and/or commercial schemes best support manipulative use?

Thank you

Simon Sheard

simon.sheard@sunderland.ac.uk

@sheard_simon



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