Ofsted Research Review Series: Mathematics

A Summary

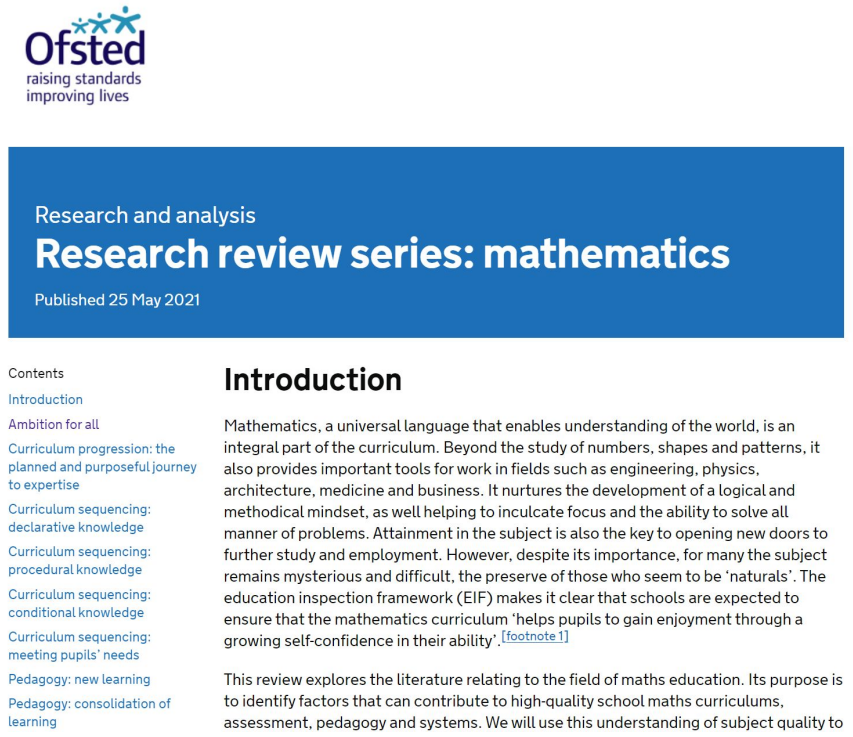
“Mathematics [is] a universal language that enables understanding of the world…”

@drstonemaths

Purpose

“This review explores the literature relating to the field of maths education. Its purpose is to identify factors that can contribute to high-quality school maths curriculums, assessment, pedagogy and systems

“We will use this understanding of subject quality to examine how maths is taught in England’s schools…”



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Research and analysis

Research review series: mathematics

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Introduction

Mathematics, a universal language that enables understanding of the world, is an integral part of the curriculum. Beyond the study of numbers, shapes and patterns, it also provides important tools for work in fields such as engineering, physics, architecture, medicine and business. It nurtures the development of a logical and methodical mindset, as well helping to inculcate focus and the ability to solve all manner of problems. Attainment in the subject is also the key to opening new doors to further study and employment. However, despite its importance, for many the subject remains mysterious and difficult, the preserve of those who seem to be ‘naturals’. The education inspection framework (EIF) makes it clear that schools are expected to ensure that the mathematics curriculum ‘helps pupils to gain enjoyment through a growing self-confidence in their ability’.[footnote 1]

This review explores the literature relating to the field of maths education. Its purpose is to identify factors that can contribute to high-quality school maths curriculums, assessment, pedagogy and systems. We will use this understanding of subject quality to

link

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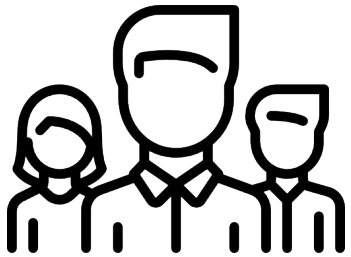
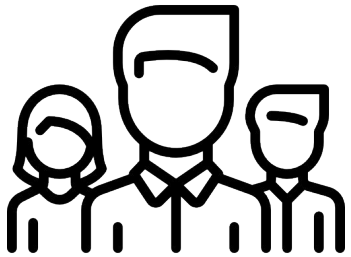


Ambition for All

- The attainment gap between low and high achievers in England is wide
- The attainment gap between disadvantaged and advantaged pupils is also wide
- There is still more that could be done to enhance mathematics education, such as reducing the shortage of specialist mathematics teachers

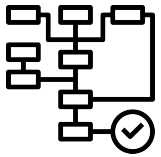


Ambition for All (ctd)

Mathematical curriculum content placed into three categories

Declarative Knowledge – I know *what*

Facts, formulas, rules, concepts

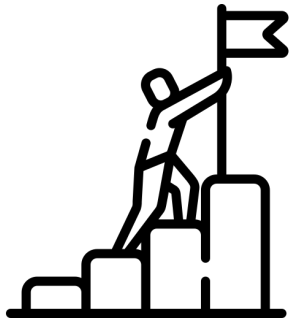


Procedural Knowledge – I know *how*

Methods, algorithms, procedures

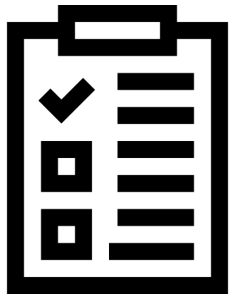
Conditional Knowledge – I know *when*

Recognition of structures and mathematical connections



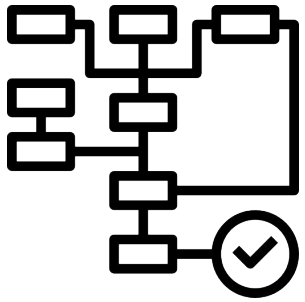
Curriculum Progression

- Pupils need to systematically learn core facts, concepts and procedures
- Strategies for problem solving are best taught when facts and procedures are well established
- The aim is for students to attain proficiency not just familiarity
- Students become more motivated if they are successful
- Successful curriculums emphasise core knowledge:
  depth over breadth



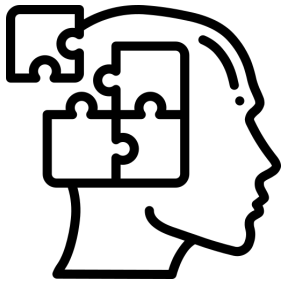
Declarative Knowledge

- Pupils who cannot quickly recall maths facts struggle due to overloading working memory
- Core declarative knowledge should be prioritised
- Pupils benefit when fundamental features and patterns are pointed out to them e.g. associativity and commutativity
- In countries that perform well the building blocks of algebra are systematically planned into the early stages of the curriculum



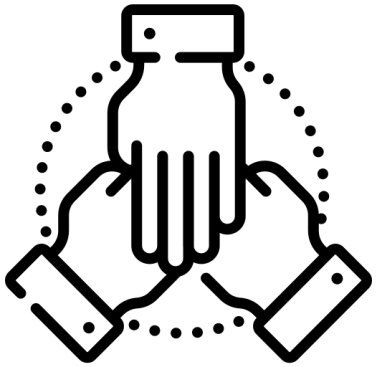
Procedural Knowledge

- Pupils can be helped with concrete or pictorial representations, but the aim should be to move towards symbols and abstract representations
- Quality over quantity – pupils benefit from fewer but more powerful representations with e.g. algebra
- Teachers should teach systematic methods that can be used in pupils' next stage of learning



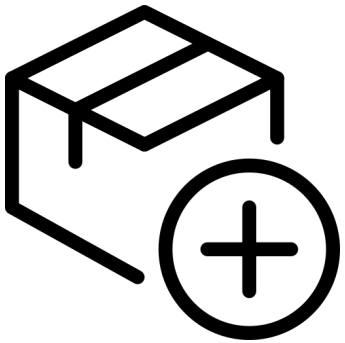
Conditional Knowledge

- Successful problem-solving is not an activity but an outcome of successful learning of facts and methods
- Solving word problems requires proficient reading
- Strategies for problem-solving are topic specific and should be covered with the relevant topic
- Pupils should build a bank of strategies to classify and solve problems by understanding when methods can be applied



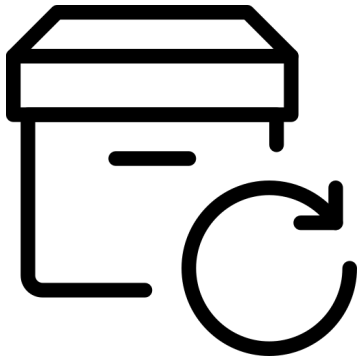
Meeting Pupils' Needs

- Teachers should plan for what pupils are thinking about, not what they are doing
- A moment of understanding does not guarantee long term learning
- Pupils should not be rushed through content
- There should be space in the curriculum for consolidation
- Pupils with SEN benefit from explicit, systematic instruction and systematic rehearsal of declarative and procedural knowledge



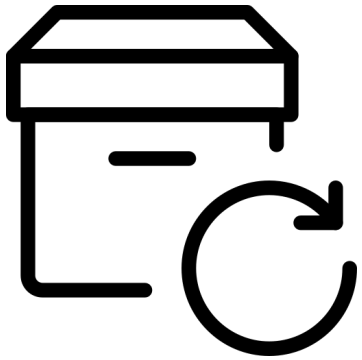
Pedagogy: New Learning

- Novice mathematics learners need systematic explicit instruction
- Variation within sets of exercises can help pupils learn patterns and connections
- Learning through open questions may be enjoyable but it does not lead to as much progress – the teacher in the room is an important mediator of the learning
- Pupils learn from worked examples, especially if the teacher helps the pupils make sense of them



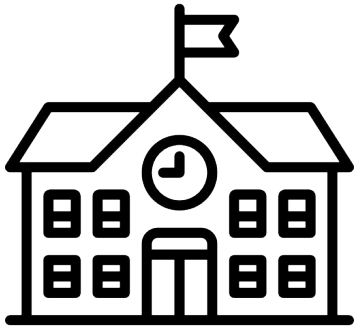
Pedagogy: Consolidation of Learning

- Pupils need regular opportunities to rehearse and apply the facts and methods they have learned
- Teachers should ensure pupils get adequate opportunities to practice
- Long-term retrieval of core content should be a focus of teachers' planning
- Pupils should initially learn content as component parts before combining these to a wider skill



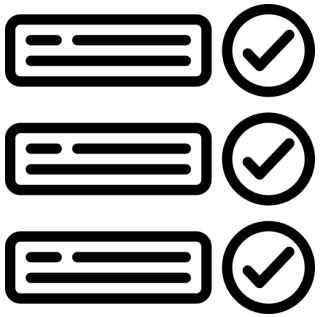
Pedagogy: Consolidation of Learning (ctd)

- The ideal environment for periods of independent work is silence – noise is especially distracting to younger pupils and those with SEN
- Group work, if tightly managed, can aid pupils' development of explanations
- Pupils' reliance on manipulatives or aids can hinder future learning – teachers should plan to move pupils away from these
- Teachers should balance the rehearsal of methods and facts with the rehearsal of proofs and explanations



Systems at the School Level

- Careful presentation of bookwork helps students recognise patterns and identify errors
- Pupils' effort is a better indicator of teacher quality than teacher-student relationships
- Novice maths teachers may not have all the tools they need
- Collaborative department approaches and observations can help improve teacher quality
- Teachers should seek to improve their subject knowledge



Conclusion

- Overall theme is that success is underpinned by systematic thinking
- These approaches seek to transform an offer of content into a guarantee that content can and will be learned
- Successful maths education starts with a detailed codification and sequencing of facts, methods and strategies, has instructional coherence and aligns rehearsal to increase understanding and remembering
- Quality and quantity of practice is the key that unlocks the developing of conceptual understanding and procedural fluency

Criticisms

There has been some criticism of this document from e.g. the ATM. Issues raised include

- Some citations appear to not align with the conclusions of the original research
- References don’t consider the context of the original study e.g. country, small sample sizes, age of participants
- Dated references
- The document is written more like a policy proposal than a research review