Lionheart Educational Trust Mathematics Curriculum

Overarching Vision

All pupils are confident in maths; equipped with strong procedural and conceptual understanding for future education and for life.

The universe cannot be read until we have learned the language and become familiar with the characters in which it is written. It is written in mathematical language. Galileo Galilei

Principles of Mathematics teaching

"Mathematics is an interconnected subject in which pupils need to be able to move fluently between representations of mathematical ideas." National Curriculum 2013

Success in mathematics comes from having deep knowledge of the rich connections within mathematical structures, facts, concepts, and procedures. Gone are the days when a superficial understanding of a mathematical procedure would carry pupils through an exam. For too long, a "skills based" approach has led to thinking of mathematics in atomised silos which remain a mystery to many. It then becomes socially acceptable (even a badge of honour) to say "I can't do maths" whereas no one would admit to being unable to read. Our curriculum and the way we teach it aims to challenge this dogma.

In Lionheart secondary schools, the curriculum is seen as a 5-year or 7-year journey. In fact, taken as a whole, it is better seen as an 11- or 13-year part of a lifelong mathematical journey.

The principles that make up our curriculum include:

Principle: Deep learning in mathematics happens when pupils have both procedural and conceptual understanding of a topic (see fig 1).

Our curriculum has an emphasis on teaching for both conceptual and procedural understanding and unpicking any shallow foundations (NCETM, 2018). A coherent plan through a topic builds the concepts to move the pupils from novice to expert. Increasing difficulty and problem solving allow pupils to flex their intellectual muscles.

Outworking in lessons: On first glance, a lesson or topic may appear "easy", but pupils are being encouraged to go deeper into the topic. For example: 16.7 – 3.9 is equivalent to 16.8 – 4. How can this result be proved? Why is one easier to answer than the other? Can this result be generalised? Under what conditions does this method become efficient or inefficient?

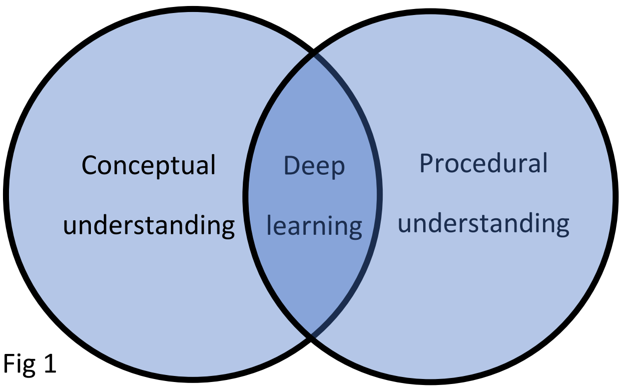


Fig 1

Principle: Deep learning in mathematics does not (necessarily) happen quickly so the curriculum stays on topics for longer.

Short bursts on a topic and endless spiralling through substantive knowledge does not aid deep leaning. Hence our curriculum stays on blocks of related content for longer (approximately 6-8 weeks). Each block builds on prior knowledge, unpicks any misunderstandings, and takes the knowledge deeper and further. Access material is provided for pupils who are not ready to work on the standard curriculum content. Low-stakes retrieval quizzing, revisiting knowledge and cumulative assessments will keep topics "live".

Outworking in lessons: Substantive knowledge is taught with classes and year groups learning together as much as possible. This way, accurate and consistent vocabulary is used and modelled, and teaching is "to the top". Differentiation may look very different in such a class with support, stretch and challenge provided by varying degrees of scaffolding and depth, rather than acceleration into new content. Extension tasks (on related content) are provided for pupils who need even more stretch.

Principle: Deep learning involves developing fluency in mathematical knowledge, so as to be able to reason mathematically, with the aim of solving mathematical problems.

Our curriculum is based on evidence (EEF, 2018) which shows that effective maths teaching includes:

- Teaching the knowledge of underlying mathematical structures and the rich connections between different areas rather than viewing mathematics as atomised and discrete topics. Multiple representations and manipulatives are used where appropriate.
- Using both summative and formative assessments to inform subsequent planning. Hence feedback becomes embedded into the planning of the next learning episode.
- Teaching knowledge so that this can be brought to bear on problem solving tasks. Rich tasks and longer problems are built into the curriculum.

Outworking in lessons: We recognise that practice is a vital part of learning ("Practice makes permanent"). This develops conceptual understanding, procedural fluency and encourages mathematical thinking and reasoning. We will regularly teach and practice key mathematical facts (e.g. multiplication tables, number bonds and theorems) as well as common mathematical procedures (e.g. arithmetic with fractions). This underpins pupils' access to curriculum content and avoids overload of working memory when focusing on new ideas.

Principle: Deep learning involves effective use of assessments.

Assessment should be used not only to track pupils' learning but also to provide teachers with information about what pupils do and do not know. It is recognised that assessments can only sample across a domain and hence teaching to the test or excessive use of exam style questions too early will not lead to sustained improvements. Assessments will be:

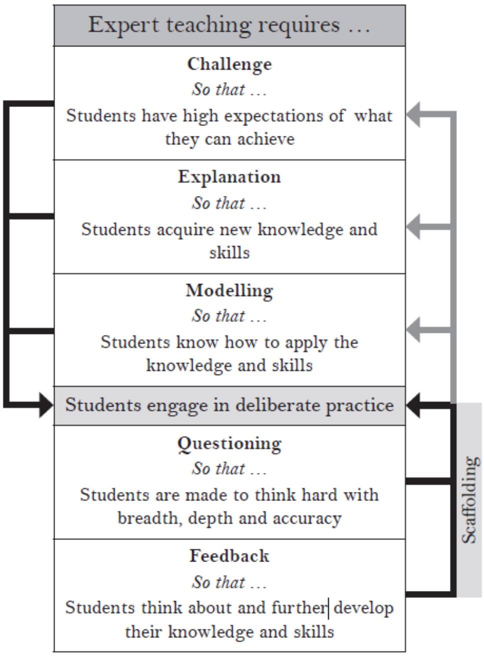
- Predominately formative
- Diagnostic pre-testing of material to be taught and pre-requisites
- Testing as a learning event rather than as assessment (Richland, Kornell, Kao 2009)

There will be regular short formative testing of topics and two common synoptic assessments during each year as well as the cross subject "Big Test".

Elements of Mathematics teaching

In planning learning episodes, the focus should be on what pupils give their attention to and what they will be thinking about rather than on what they will do. As Willingham says, 'Memory is the residue of thought' (Willingham 2010).

We expect to see the following in each learning episode (which could be a part of a lesson, a single lesson, or a series of lessons). Our aim is to support teachers of maths across Lionheart schools to constantly improve each of these aspects of their teaching within their own personal pedagogy; so that every pupil receives expert maths teaching.



(Allison and Tharby, 2017)

Challenge

- Appropriate challenge for all pupils with particular attention to the highest attaining and pupils at risk of underachieving. Allowing and encouraging pupils to struggle in order to move them on.
- A mixture of tasks some of which build pupils' confidence and others which stretch them academically.
- Raising pupils' expectations of what they can achieve by teaching to the top with appropriate scaffolding.

Explanation

- Teacher-led instruction is an important part of learning episodes, where complex ideas are communicated to pupils.
- Clear explanations include building on prior knowledge, breaking a concept into small steps, exposing misconceptions and the use of concrete examples.
- Exposing the relationships and links between areas of mathematics.
- Deliberate and precise use of mathematical language, which is explained. Expectation that pupils will use correct mathematical language.

Modelling

- Carefully thought-out models used alongside explanations to secure and deepen conceptual understanding including concrete and pictorial representations.
- Use of worked examples to demonstrate techniques and model ideas and approaches.
- Joint construction and practice of techniques leading to greater independence.
- Modelling expert approaches to problems.
- Use of technology, where appropriate, to model approaches and answers.

Deliberate practice

- Practice moves pupils towards independence and develops memory, which is the essence of learning.
- Practice should include intelligent variation and pupils should have to think hard. Repetitive practice which can be completed mechanically but doesn't promote thought should be kept to a minimum.
- Practice questions to develop mathematical fluency (first aim of the national curriculum (NC)) and GCSE Assessment Objective AO1 (use standard techniques).
- Further deliberate practice for mathematical reasoning, communication and problem solving (NC 2nd and 3rd aim of NC, GCSE AO2 and AO3).
- Integration of previous content into practice to emphasise links between concepts and to aid retrieval.
- Overlearning to help build automaticity of core knowledge, so that pupils' working memory can be freed up to focus on other aspects of questions.

Questioning

- Questioning may be used to lead the learning on a topic, to key into prior knowledge, extend pupil's thinking and develop their metacognition.
- Questioning allows the teacher to get instant feedback from pupils.
- Pupils are encouraged to respond to higher order questions (e.g. give me another example, explain your reasoning, justify your answer) to help deepen their understanding (Rosenshine, 2012)
- The use of mini-white boards, technology, or other ways of capturing all pupils' responses is encouraged.

Feedback

- Feedback is given throughout a lesson, over a sequence of lessons and following assessments.
- Feedback can take a variety of forms:
    - The next learning sequences/lesson. (NCETM 2016)
    - Verbal feedback, either individual or whole class.
    - Written feedback, often as live marking.
- As appropriate, pupils are given opportunities to respond to feedback by self-assessment, completing "narrowing the gap" tasks, making corrections and identifying next steps.
- The expectation is that lesson design and planning are the most effective way of providing detailed feedback. (NB: this is sometimes hard to evidence in an exercise book)

Scaffolding

- All pupils are encouraged to do their best and be resilient.
- Explanations, examples, and tasks are scaffolded to give all pupils access to the appropriate material with the aim of narrowing attainment gaps.
- Where setting is used, scaffolding will be shown by the explanations and models used, or the demand of the questions used in deliberate practice.
- Pupils are encouraged to engage in their independence and self-scaffolding for example by having rich mathematical discussions with their peers rather than an over reliance on teacher support.

Curriculum Overview

Across the five year plan our curriculum includes all the content from the KS3 and KS4 programmes of study as well as some additional content that broadens our pupils' mathematical experiences. At KS3 we consolidate and deepen the mathematical understanding pupils bring from KS2, aiming to ensure strong foundations on which to build.

This five-year curriculum is in the process of being developed, with Year 7-9 in place for 2021-2022 and Y10-11 in development. The curriculum is based around blocks of related content, each lasting several weeks. Within each block there are a small number of related topics. Small steps break down the knowledge to be learned to provide clarity to teachers and pupils.

Year 7	1. The Grammar of Algebra	2. Additive Relationships	3. Multiplicative Relationships	4. Geometrical Reasoning	5. Fractions		
Year 8	6. Percentages	7. Sets and Building Numbers	8. Describing using Algebra	9. 2-D geometry	10. Proportional reasoning	11. 3-D geometry	12. Organising and Representing Data
Year 9	13. Graphs and proportion	14. Understanding Probability	15. Algebraic Manipulation	16. 2-D Geometry Two	17. Linear Equations and Inequalities	18. Geometry of Triangles One	
Year 10 (planned)	19. Comparing Data	20. Non-Linear Algebra	21. Number	22. Geometry	23. Reasoning	24. Geometry and Number	25. Sampling and Probability
Year 11 (planned)	26. Algebra and geometry	27. Number and statistics	28. Kinematics and Functions	Revision and extension	Exams		
Year 10 (current)	Number	Linear Algebra and Graphs	Geometry,bearings, constructions, loci	Trigonometry Pythagoras	Probability	Mensuration	
Year 11 (current)	Non-linear algebra and graphs	Statistics	Mensuration	Transformations and vectors	Kinematics, functions, sequences and Iteration		