Lionheart Academies Trust Mathematics Curriculum

Overarching Vision

No one in a Lionheart school says, “I’m no good at maths”.

> 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

We believe that 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 students 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 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?

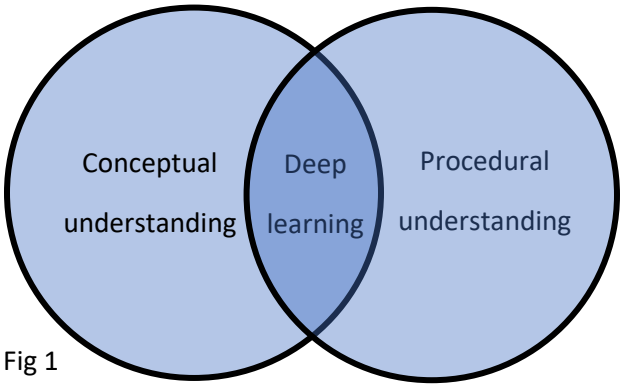


Fig 1

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 topics for longer (approximately 6 weeks). It is based on the Maths Mastery curriculum overview (Mathematicsmastery.org, 2018). Each unit builds on prior knowledge, unpicks any misunderstandings and takes the knowledge deeper and further. Access material is provided for students who are not ready to work on the standard curriculum content. Low-stakes 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 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 students 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 in to the curriculum. Strategies to access these are made explicit.

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 students' 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 (Christodoulou, 2017), 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 Pretesting of material to be taught and pre-requisites
- Testing as a learning event rather than as assessment (Richland, Kornell, Kao 2009)

Across the LAT schools, there is freedom for departments to use summative assessments to fit their own needs, however there will be three common assessments during each year.

Curriculum Overview

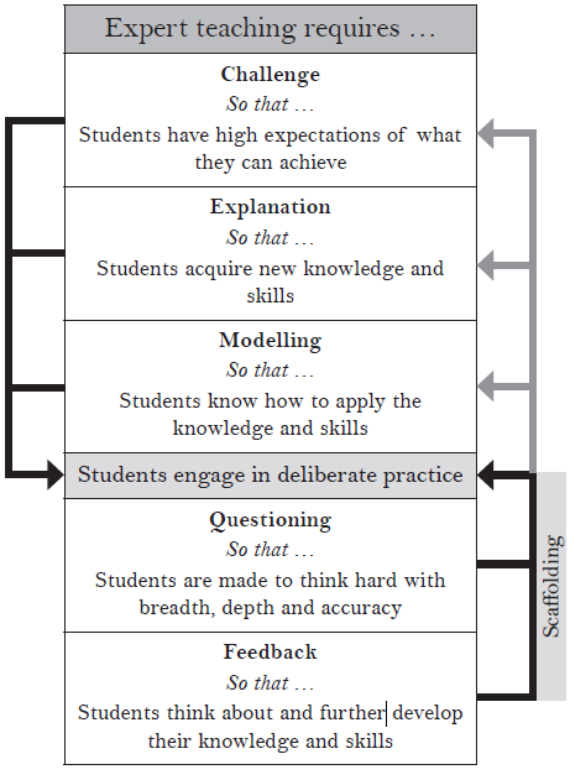
This is a period of significant transition at Lionheart Schools. The curriculum is based on the Mathematics Mastery curriculum (Mathematicsmastery.org, 2018). Coverage of the KS3 POS and KS4 exam syllabus is covered under the following broad headings:

	Autumn 1	Autumn 2	Spring 1	Spring 2	Summer 1	Summer 2
Year 7	Add and subtract	Multiply and divide	Geometry	Fractions	Algebra	Percentages and statistics
Year 8	Number	Algebra	2-D geometry	Proportional reasoning	3-D geometry	Statistics
Year 9	Graphs and proportion	Algebra	2-D geometry	Equations and inequalities	Geometry	Statistics
Year 10	Number	Geometry	Reasoning	Geometry and Number	Sampling and probability	Algebra
Year 11	Algebra and geometry	Number and statistics	Revision and Extension 1	Revision and extension 2	Revision and extension 3	Exams

Elements of Mathematics teaching

In planning learning episodes, the focus should be on what students should think 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 student receives expert maths teaching.



(Allison and Tharby, 2017)

Challenge

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

Explanation

- Teacher-led instruction is an important part of lessons, where complex ideas are communicated to students.
- 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 students will use 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 answers.

Deliberate practice

- Practice moves students towards independence and develops memory, which is the essence of learning.
- 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).
- Overlearning to help build automaticity.

Questioning

- Questioning may be used to lead the learning on a topic, to key into prior knowledge and extend student's thinking.
- Questioning allows the teacher to get instant feedback from students.
- Students 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 student responses is encouraged.

Feedback

- Feedback is given throughout a lesson, over a sequence of lessons and after formal assessments.
- Feedback can take a variety of forms:
    - The next learning sequences/lesson. (NCETM 2016)

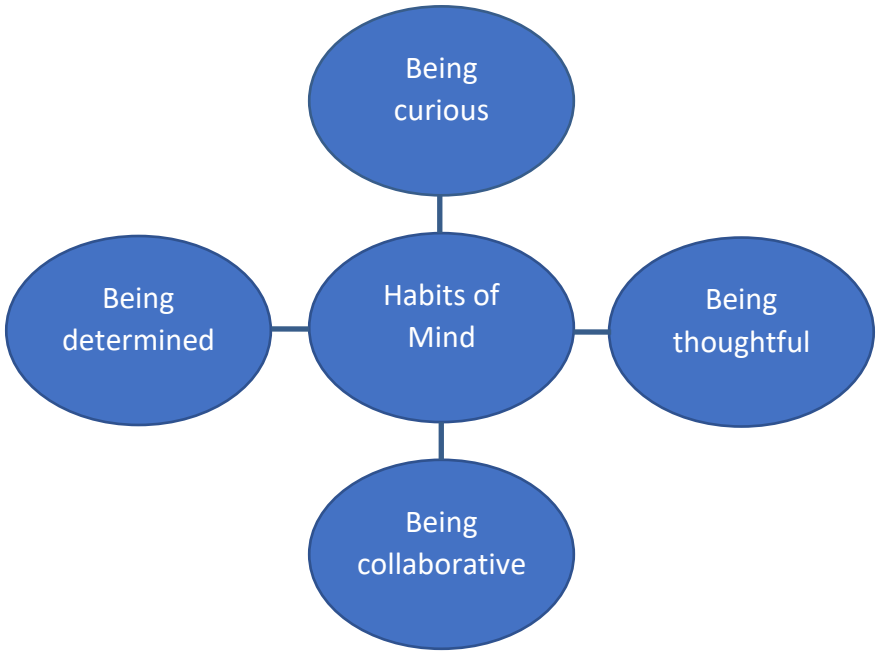
    - Verbal feedback.
    - Written feedback.
- As appropriate, students are given opportunities to respond to feedback by self-assessment, completing "narrowing the gap" tasks, making corrections and identifying next steps.
- The expectation is that lesson design and planning are the most effective way of providing detailed feedback. (NB this is sometimes hard to evidence in an exercise book)

Scaffolding

- All students are encouraged to do their best and be resilient.
- Work is scaffolded to give all students 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.
- Students 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.

Mathematical Habits of Mind

We believe that all students can get better at mathematics and are able to develop these habits of mind:



Nrich, 2018

Being Curious

Good thinkers are curious and ask good questions. They are excited by new ideas and are keen to explore and investigate them.

Being Thoughtful

Good thinkers are thoughtful and reflective. They think critically and can explain and justify the choices that they make. They become absorbed in what they are doing and show attention to detail. They look back on what they have done in order to learn from both successes and failures.

Being Collaborative
Good thinkers collaborate and communicate. They work productively with other people, valuing different points of view. They are willing to change their mind when presented with convincing arguments. They know when to seek help, when to support others, when to speak up and when to compromise.

Being Determined
Good thinkers are determined and persistent. They don't give up easily, and are motivated to work hard and keep going when faced with challenges. They recognise that we all fail sometimes, and when this happens, they bounce back and try alternative approaches.

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