

Mastery Scheme of Work: GCSE Maths re-sit

Introduction

This scheme of work has been written by the colleges involved in the CfEM programme. It was written by the sector, for the sector, based on CfEM's [Five Key Principles of Teaching for Mastery](#) in FE. It contains links to 30 mastery lessons written by teachers during the programme, supplemented by six others produced for research purposes by the University of Nottingham. Together, these cover most (but not all) of the scheme of work.

The intention is to provide an exemplar that can be adapted and used by maths teachers and managers in colleges across England who are grappling with the issues of teaching GCSE re-sits within a window of 30 weeks or less to learners who are frequently disengaged by previous negative experiences of the subject.

Finally, our scheme of work is based on a 90 GLH model used in many FE colleges and consists of 30 weeks of two 1.5-hour lessons per week. The scheme and the lessons can, however, be adapted to fit other curriculum models.

Overview

Although the scheme of work and lessons relating to it have been informed by all five Key Principles of Teaching for Mastery, the structure of the scheme of work presented here has been informed by one of the key principles in particular: **prioritising curriculum coherence and connections**. In terms of structuring the scheme of work, this means:

- taking account of issues of **learner engagement and resilience**, particularly in the early part of the academic year
- **focusing on a limited number of key concepts** rather than superficial coverage of a larger amount of material
- sequencing to enable learners to see **links between mathematical concepts**
- consistent use of **familiar representations across different topics** to enhance understanding of mathematical structure.

Rationale

The GCSE curriculum is made up of a few big, linked ideas, and this scheme of work (SoW) has been designed in a way to reduce students' cognitive load supporting the demands on their working memory while helping them to think deeply about the underlying mathematical concepts. This is in contrast to traditional teaching in a

GCSE mathematics re-sit classroom, where students are provided with isolated procedures or algorithms presented as disconnected topics that need to be remembered but cannot be readily applied to everyday life situations.

Evidence from the analysis of students' scripts carried out by CfEM shows that those who miss out on Grade 4 need to develop their thinking on key concepts such as percentages and fractions, rather than try to remember algorithms for solving simultaneous equations or how to rearrange an equation. This SoW addresses this by removing topics that require too many steps of understanding for our students, taking into account the exam's low weighting.

The critical aim is to develop an improved number sense, and while some algebra is covered, there are very few topics beyond the algebra basics within this SoW. Similarly, with geometry, this SoW concentrates on 2D and 3D basic concepts such as area and volume and does not build into topics such as Pythagoras and trigonometry. By removing several more complex topics, we give students the best possible chance of success by covering enough content to allow them to comfortably gain a Grade 4, while also spending enough time on each topic for them to be able to address their misconceptions and make progress. In sequencing this SoW, we have also reviewed different models and representations of mathematical concepts as well as the efficacy of using these mastery approaches from action research undertaken by CfEM colleges.

Autumn term – first half-term

Our SoW commences with two lessons focusing on learner **engagement and resilience**, with the intention of addressing from the start the negative attitudes and fixed mindsets that learners frequently present. However, it is important that these key messages are reinforced regularly throughout the year. For more ideas about this, refer to the screencasts on engagement and resilience produced by CfEM centres and CfEM's [Motivation and Engagement Handbook](#).

Beyond this first week, the autumn term focuses on **number and proportional reasoning** and all its interconnected topics which are assigned at the start of the academic year. For direct proportion, we have chosen a **ratio table** as the initial model along with its graphical representation as a straight line. Research conducted by CfEM has shown that ratio tables help students organise their thinking, make sense of proportion, and achieve a greater degree of flexibility in their approaches.

Another key representation introduced in the first half term is the **bar model**, which provides an invaluable way of helping learners make sense of **fractions and ratios** (and many other mathematical concepts beyond), while **arrays and area models** are used to support learners' understanding of **multiplication and division**.

Autumn term – second half-term

In the second half term, the SoW continues to make use of the bar model and array as representations while number concepts such as factors and multiples are introduced and fractions are explored in more depth.

Percentages are explored next, using bar models to represent common percentages and their fraction and decimal equivalents, before making links with **multiplicative reasoning** and exploring applications such as interest rates, exchange rates, and the concept of growth. The ratio tables and bar models become less useful at this point, and the **double-number line (DNL)** is introduced to provide a visual representation of percentage increase, decrease, and reverse percentage. In traditional teaching, students are often confused about different percentage situations and what algorithm they need. In our lessons we take them over the hundred and introduce a multiplier as a method which can be used for different percentages with a DNL, while keeping their existing methods, so they are able to choose which one they prefer. It is hoped that by the end of the first term, using mastery models and representations and by making connections, direct proportions, percentages, fractions and ratios will be better understood as a whole.

Spring and summer terms

The SoW broadens in the spring term to extend learning to **algebra, geometry, and finally statistics and probability**, with connections made to learning in the autumn term, including reference to ratio tables and bar models where appropriate.

For algebra, CfEM has had some success with manipulatives that have been incorporated into this SoW, starting with directed numbers using **double-sided counters** and progressing to **algebra tiles** as an introduction to collecting like terms and basic equations and **multi-link cubes** for sequences. These are the only three manipulatives used in this SoW, but it is not essential that you have physical manipulatives available as online resources are signposted.

The final four weeks of the SoW are left open for colleges to focus on revision and exam preparation.

Autumn: first half-term

Lesson	Block	Section	Lesson topic	Lesson objectives	Model or representation
1	Engagement and resilience		Attitudes to maths and getting unstuck	<ul style="list-style-type: none"> Motivate, engage and develop resilience in FE maths resit learners Get to know maths learners and recognise their previous experiences Equip learners with strategies to progress in their maths Promote a safe, positive learning environment in the classroom 	
2			Mindsets, resilience and number sense	<ul style="list-style-type: none"> Categorise attitudes into fixed or growth mindsets Recognise that progress is maximised when in the growth zone Use ratio tables to answer proportion questions State characteristics of mathematical resilience 	Ratio table
3	Proportional reasoning 1	Direct proportion	Direct proportion	<ul style="list-style-type: none"> Identify when two quantities vary in direct proportion to each other Understand the multiplicative relationship between two quantities (non-calculator) Solve simple proportional problems using efficient methods with ratio tables 	Ratio table
4			Best buys	<ul style="list-style-type: none"> Investigate pricing structures for items that come in different sizes to determine what is the best buy Solve simple best buy problems using efficient methods and ratio tables 	
5			Scales, maps and units	<ul style="list-style-type: none"> Convert metric units of measurement Use a scale to find lengths Represent a proportional situation in a ratio table 	

Lesson	Block	Section	Lesson topic	Lesson objectives	Model or representation
6			Speed	<ul style="list-style-type: none"> Convert between units of time (seconds, minutes and hours) Understand the meaning of average speed and the factors that can affect average speed in real-life contexts Solve problems that involve distance, time and speed 	Bar model
7		Parts and wholes	Basic fractions	<ul style="list-style-type: none"> Understand what a fraction is and be able to link this to proportion Find a fraction of an amount Find the whole amount from a fraction Find a half without finding the whole by drawing a bar model 	
8			Ratio and fractions (University of Nottingham lesson)	<ul style="list-style-type: none"> Write a ratio as a fraction, and vice versa Divide a given quantity into parts in a given part-part and part-whole ratio Solve multi-step problems using ratios and fractions Use representations to provide insight into solving problems 	
9		Ratio	Sharing in a ratio	<ul style="list-style-type: none"> Understand how ratios correspond with real-world situations Use ratio reasoning to solve whole-to-part and part-to-part simple problems Use bar model representations to provide insights into solving problems 	
10			Using ratios	<ul style="list-style-type: none"> Use the difference between ratio parts to solve problems using bar models Write equivalent ratios including in the form 1:n or n:1 	

Lesson	Block	Section	Lesson topic	Lesson objectives	Model or representation
11	Numerical reasoning 1	Working with number	Multiplication and estimation	<ul style="list-style-type: none"> Explore, evaluate and select different representations for multiplication, identifying any potential misconceptions Apply various methods and representations to a singular context using integers and decimals Apply efficient mastery methods to questions in different contexts Apply estimation, inversion and rounding in order to check accuracy of answers 	Array and area model
12			Division and estimation	<ul style="list-style-type: none"> Explore and evaluate different representations for division, identifying any potential misconceptions Apply various division methods and representations to a context involving integers and decimals Apply estimation, inversion and rounding in order to check accuracy of answers 	

Autumn: second half-term

Lesson	Block	Section	Lesson topic	Lesson objectives	Model or representation
13	Numerical reasoning 1	Factors, multiples and primes	Factors and product of prime factors (University of Nottingham lesson available for Factors and Multiples)	<ul style="list-style-type: none"> Understand the terms 'factor', 'prime number' and 'prime factor' List the factors of a given number Find the highest common factor of two numbers Use prime factorisation to express a number as a product of its prime factors 	Array
14			Multiples and LCM	<ul style="list-style-type: none"> Understand the term 'multiple' List a set number of the multiples for a given number Find the lowest common multiple of two numbers Solve LCM word problems 	
15		Working with equivalent fractions	Comparing and equivalence of fractions	<ul style="list-style-type: none"> Find equivalent fractions for a given fraction Compare two or more fractions (including those with different denominators) Order fractions in ascending or descending order (including those with different denominators) 	Bar model
16			Adding and subtracting fractions	<ul style="list-style-type: none"> Adding and subtracting fractions with common denominators Adding and subtracting fractions with different denominators using array representations Recognising equivalent fractions using array representations Simplifying fractions 	Array
17		Multiplying and dividing fractions	Multiplying fractions	<ul style="list-style-type: none"> Multiply proper and improper fractions (including negative numbers) Multiply mixed numbers (including negative numbers) Multiply fractions in context 	Bar model

Lesson	Block	Section	Lesson topic	Lesson objectives	Model or representation
18			Dividing fractions	<ul style="list-style-type: none"> Divide a whole number by a fraction Divide a fraction by a whole number Divide any fraction by a fraction Be able to draw a bar model to support thinking when dividing fractions 	
19	Proportional reasoning 2	Working with percentages	Benchmark percentages and equivalent fractions and decimals	<ul style="list-style-type: none"> Work with fractions, decimals and percentages using multiple representations Use benchmark percentages and bar models to solve non-calculator percentage problems 	Bar model
20			Multiplicative reasoning (University of Nottingham lesson)	<ul style="list-style-type: none"> Understand the multiplicative relationship between two quantities (non-calculator) Solve multi-step currency or unit conversion problems (calculator) Understand how to use representations to provide insight into problem solving 	Double number line
21		Using percentages	Percentages with a calculator (Alternative University of Nottingham lesson also available)	<ul style="list-style-type: none"> Work out how to increase and decrease a quantity with a calculator, using a multiplier Solve a range of percentage questions using a multiplier (percentage of an amount, percentage increase/decrease, an amount as a percentage, reverse percentages) Use a double number line to see the common mathematical structure across a range of percentage questions 	
22			Interest rates and growth	<ul style="list-style-type: none"> Work out overall percentage change over two or more successive periods Use percentages in a financial literacy context, e.g. simple interest and tax Work out compound interest for two, or more, periods of time 	

Lesson	Block	Section	Lesson topic	Lesson objectives	Model or representation
23		Proportion problems	Exchange rates	<ul style="list-style-type: none"> Use graphs to convert currency Understand how to use double number lines to provide insight into solving currency conversion problems Use approximation to check currency conversion calculations 	
24			Problem solving with ratio, fractions and percentages	<ul style="list-style-type: none"> Use strategies to deconstruct complex worded questions and identify relevant information and processes Use bar models and other representations to solve problems with fractions, ratios and percentages Develop resilience in approaching complex worded problems 	Bar model

Spring: first half-term

Lesson	Block	Section	Lesson topic	Lesson objectives	Model or representation
25	Numerical reasoning 2	Working with indices	Powers, roots and index laws	<ul style="list-style-type: none"> Understand index and root notation Recognise powers of 2, 3, 4, 5 Apply index laws to add and multiply numbers with positive integer powers 	Multi-link cubes
26			Standard form	<ul style="list-style-type: none"> Understand the value of positive and negative powers of 10 Convert numbers between ordinary and standard form Calculate with standard form 	Place value grids
27	Algebraic reasoning 1	Working with algebra	Directed numbers	<ul style="list-style-type: none"> Understand and use directed numbers in the context of temperature Make valid generalisations about the effect of operations on direct numbers Input equations with negative numbers effectively into a calculator 	Number line Double-sided counters
28			Algebra notation and collecting like terms	<ul style="list-style-type: none"> Recognise the difference between simplified and non-simplified expressions Introduce the use of algebra tiles to represent terms in expressions Add and subtract variables, including those with indices Simplify expressions by collecting like terms 	Algebra tiles
29			Substitution and formulae	<ul style="list-style-type: none"> Use the order of operations to navigate through expressions and formulae Use formulae in words and numbers, recognising links between language and numbers Substitute positive and negative numbers in algebraic formulae Use variations of concepts to promote mathematical thinking and discussion, building on existing knowledge relevant for substitution and formulae 	

Lesson	Block	Section	Lesson topic	Lesson objectives	Model or representation
30		Understanding equations	Expand and factorise (Alternative University of Nottingham lesson also available)	<ul style="list-style-type: none"> Simplify algebraic expressions to maintain equivalence by multiplying a single term over a bracket Simplify algebraic expressions to maintain equivalence by multiplying a single term over a bracket and collecting like terms Simplify algebraic expressions to maintain equivalence by taking out common factors 	
31			Solving equations (Alternative University of Nottingham lesson also available)	<ul style="list-style-type: none"> Understand the steps needed to solve an equation Solve one-step and multi-step equations Use visual representations to provide insight into solving equations 	
32			Function machines	<ul style="list-style-type: none"> Understand how function machines represent the relationship between variables Use a function machine to calculate an output when given an input Understand the concept of reverse operations Use a function machine to calculate an input when given an output 	
33			Algebraic thinking in problem solving (University of Nottingham lesson)	<ul style="list-style-type: none"> Represent contextual problems mathematically Use diagrams to represent mathematical structure Determine the value of an unknown in a problem Solve problems involving angles 	
34	Numerical reasoning 3	Using a calculator	<ul style="list-style-type: none"> Be familiar with key functions on a calculator, e.g. brackets, index notation, square and cube roots, Pi, fraction notation Use a calculator to answer questions across a variety of topics 		

Lesson	Block	Section	Lesson topic	Lesson objectives	Model or representation
35	Geometric reasoning	Working with shapes	Properties of 2D shapes	<ul style="list-style-type: none"> Name and identify the properties of a range of 2D shapes Sort and classify different types of triangles and quadrilaterals according to their properties Identify the sum of the interior angles of triangles and quadrilaterals 	
36			Area and perimeter of rectilinear shapes and compound shapes	<ul style="list-style-type: none"> Explore the area and perimeter of squares, rectangles, triangles and compound shapes Understand the concepts of area and perimeter and use them in a range of problem-solving situations 	

Spring: second half-term

Lesson	Block	Section	Lesson topic	Lesson objectives	Model or representation
37	Geometric reasoning		Circles	<ul style="list-style-type: none"> Calculate the area and perimeter of circles, semicircles and quadrants (in terms of π or to an appropriate degree of accuracy) Explore problems involving the area or perimeter of compound shapes that include circles, semicircles or quadrants Apply knowledge learned to exam-style questions 	
38			Surface area and volume	<ul style="list-style-type: none"> Identify properties of common 3D shapes Through exploration, calculate volume and surface area of common 3D shapes Use knowledge of volume and surface area for problem solving questions 	
39		Transformations	Reflections and translations	<ul style="list-style-type: none"> Reflect a shape across a drawn mirror line, the x or y axis, or the equation of an undrawn line Identify a transformation as a reflection and give the line of reflection Translate a shape vertically, horizontally, and in both directions (including vector notation) Identify the transformation of a shape as translation and describe the translation using vector notation 	
40			Rotation and enlargement	<ul style="list-style-type: none"> Rotate a shape about a given point (90 degrees clockwise, anticlockwise and 180 degrees) Describe the rotation of a shape including the magnitude and direction of the rotation and the point of rotation Enlarge a shape by a given (positive) scale factor Describe the enlargement of a shape by giving the scale factor of the enlargement 	Ratio table

Lesson	Block	Section	Lesson topic	Lesson objectives	Model or representation
41		Geometric reasoning	Geometric reasoning (University of Nottingham lesson)	<ul style="list-style-type: none"> Understand what it means for lines to be parallel Calculate missing angles Use angles to determine whether lines are parallel Develop fluency and understanding when reasoning with angles 	
42			Bearings	<ul style="list-style-type: none"> Understand bearing notation Understand the relationship between bearings and compass points Measure the bearing from one point to another 	
43	Statistical reasoning	Working with graphs and charts	Graphs and charts	<ul style="list-style-type: none"> Read and interpret pictograms, bar charts and pie charts Understand common errors when constructing graphs and charts Construct pie charts 	Ratio table
44			Scatter graphs	<ul style="list-style-type: none"> Interpret scatter graphs Draw and interpret a line of best fit Understand that correlation does not imply causation 	
45		Working with averages	Averages and range	<ul style="list-style-type: none"> Understand the difference between mean, mode and median Be able to use the appropriate average for different purposes Understand that range is the data spread and not an average 	

Lesson	Block	Section	Lesson topic	Lesson objectives	Model or representation
46			Frequency charts and averages (University of Nottingham lesson)	<ul style="list-style-type: none"> • Construct and interpret frequency charts • Find the averages and range for a set of data • Understand how the mean, median, mode and range summarise data • Use different representations of data to provide insight into mathematical structure 	
47		Working with probability	Basic probability	<ul style="list-style-type: none"> • Review the equivalence of fractions, decimals and percentages • Find the simple probability of equally likely events as a fraction, decimal or percentage • Locate the probability of simple events and mutually exclusive events on a probability scale 	
48			Using frequencies and probabilities (University of Nottingham lesson)	<ul style="list-style-type: none"> • Interpret and construct frequency tree diagrams • Use approximate values to produce a probability model • Calculate probabilities using probability tree diagrams • Use representations to reveal mathematical structure 	

Summer: first half-term

Lesson	Block	Section	Lesson topic	Lesson objectives	Model or representation
49	Algebraic reasoning 2	Working with sequences	Arithmetic sequences	<ul style="list-style-type: none"> Understand the concept of arithmetic sequences Derive the nth term of sequences generated from a context Apply nth term formula in both theoretical and practical contexts 	
50			Understanding straight line graphs (University of Nottingham lesson)	<ul style="list-style-type: none"> Understand how linear relationships are represented by straight line graphs Understand gradient as steepness and rate Interpret the y-intercept as a constant Use graphs to identify information about a relationship Make connections between equations of a straight line and their graphical representations 	
51		Algebra and graphs	Interpreting graphs for rates of energy usage and pay	<ul style="list-style-type: none"> Use proportional relationships and ratio tables to solve real-world problems involving rates of pay or energy consumption Draw and interpret graphs to solve problems involving rates, e.g. how many hours required to earn an amount, given a fixed wage per hour 	Ratio table
52			Distance-time graphs	<ul style="list-style-type: none"> Interpret information from distance-time graphs Plot information onto a distance-time graph 	
53	<i>Exam preparation and first exam</i>				
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