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Shaping Success in Maths and English

GCSE re-sits: develop your practice (Level 5 module) maths
Session 5

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WELCOME

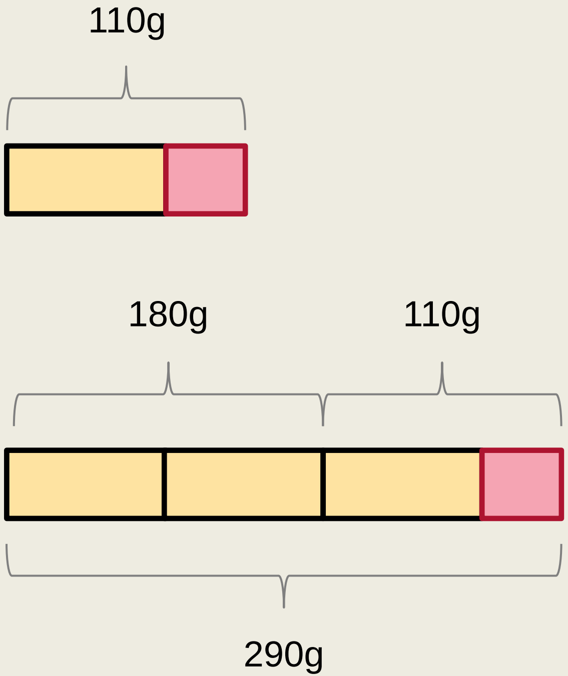
Starter activity

Alan puts some brown sugar on a dish. The total weight of the brown sugar and the dish is 110g.

Bella puts three times the amount of brown sugar that Alan puts on an identical dish. The total weight of the brown sugar and the dish is 290g.

Find the weight of the brown sugar that Bella puts on the dish.

Singapore Bar Model



2 units = 180g

1 unit = 90g

3 units = 270g

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SESSION OBJECTIVES

Learning outcomes

Explain how some countries have been able to improve the maths performance of their learners?

Discuss how teaching approaches used in some other countries could be applied to teaching GCSE maths?

Can you …

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01

International Practice

PROGRAMME FOR INTERNATIONAL STUDENT ASSESSMENT (PISA) - 2015

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1	**Singapore**
2	Hong Kong
3	Macau
4	Taiwan
5	**Japan**
6	**China**
7	South Korea
8	Switzerland
9	Estonia
10	Canada
11	**Netherlands**
12	Denmark
13	Finland
14	Slovenia
15	Belgium

16	Germany
17	Poland
18	Republic of Ireland
19	Norway
20	Austria
21	New Zealand
22	Vietnam
23	Russia
24	Sweden
25	Australia
26	France
27	**United Kingdom**
28	Czech Republic
29	Portugal
30	Italy

Maths teaching approaches

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“The review of international practices demonstrates that no one single approach is appropriate for learners;
approaches must be combined and tailored according to the specific needs of the learners being taught.
There are, however, approaches that could be adapted to, and useful for, the UK context”

(The Research Base, 2014).

Singapore maths

Students can under perform in maths because they find it boring or they can't remember all the rules.
The Singapore method of teaching maths develops pupils' mathematical ability and confidence without having to resort to memorising procedures to pass tests - making maths more engaging and interesting.

Singapore maths

In the 1970s Singapore students were performing poorly in maths.

Maths consisted of -

– rote memorisation

– tedious computation

– following procedures without understanding.

Singapore maths (influences)

Cockcroft report (1982)

– *“The ability to solve problems is at the heart of mathematics”.*

Skemp (1976)

– Relational understanding and instrumental understanding.
– Ability to perform a procedure (instrumental) and ability to explain the procedure (relational).
– Relational understanding is necessary if learners are to progress beyond seeing maths as a set of arbitrary rules and procedures.

Singapore maths (influences)

Bruner (1966)

– Introduced the term ‘scaffolding’.

  - Learners build on the skills they have already mastered.
  - Support can be gradually reduced as learners become more independent.

– Three modes of representation

  1. Enactive (concrete or action-based)
  2. Iconic (pictorial or image-based)
  3. Symbolic (abstract or language-based).

– Spiral curriculum

  - Topics are revisited (at a more sophisticated level each time).

Bruner, J.S. (1966) *Toward a Theory of Instruction*. Cambridge, MA: Harvard University Press.

Singapore maths (influences)

Dienes (1960)

– Multiple embodiment (use different ways to represent the same concept).

– Dienes blocks.

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02

Concrete, pictorial, abstract

Concrete -> Pictorial -> Abstract

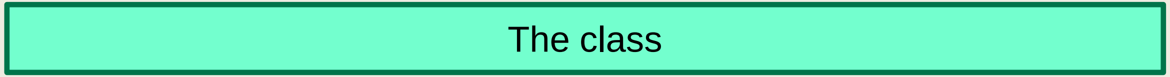
Model the concepts at each stage.
Use a variety of representations.
Don’t rush through the stages.
Learners will gain an understanding of the underlying concepts through hands-on learning activities that lay a foundation for abstract thinking.

Visualisation (Singapore Bar Model)

A tool used to visualise mathematical concepts and to solve problems.
Used extensively in Singapore.
Translate information into visual representations (models) then manipulate the model to generate information to solve the problem.

Visualisation (Singapore Bar Model)

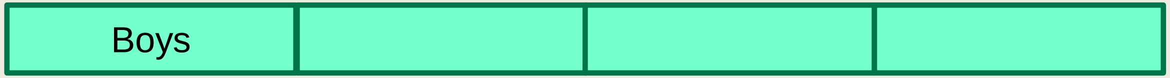
In a class, 18 of the students are girls.
A quarter of the class are boys.
Altogether how many students are there in the class?



The bar represents the whole class.

Visualisation (Singapore Bar Model)

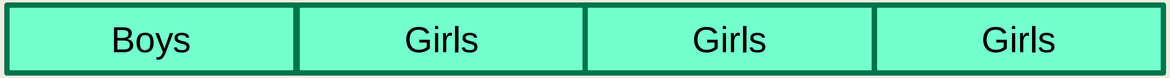
In a class, 18 of the students are girls.
A quarter of the class are boys.
Altogether how many students are there in the class?



Folding the bar into quarters allows us to represent the boys as a fraction of the whole class.

Visualisation (Singapore Bar Model)

In a class, 18 of the students are girls.
A quarter of the class are boys.
Altogether how many students are there in the class?



The rest of the class must be girls.

Visualisation (Singapore Bar Model)

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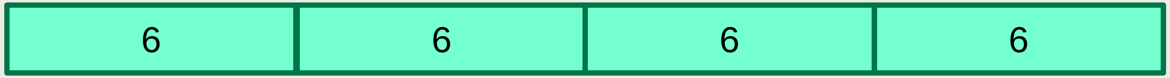
In a class, 18 of the students are girls.
A quarter of the class are boys.
Altogether how many students are there in the class?

Boys	6	6	6

There are 18 girls so each of the ‘girls’ sections must represent 6.

Visualisation (Singapore Bar Model)

In a class, 18 of the students are girls.
A quarter of the class are boys.
Altogether how many students are there in the class?



And the boys section must also equal 6.
Total number in the class is 4 x 6 = 24.

Visualisation (Singapore Bar Model)

Sophie made some cakes for the school fair. She sold $\frac{3}{5}$ of them in the morning and $\frac{1}{4}$ of what was left in the afternoon. If she sold 200 more cakes in the morning than in the afternoon, how many cakes did she make?

Singapore maths

Summary

- Emphasis on problem solving and comprehension, allowing students to relate what they learn and to connect knowledge.
- Careful scaffolding of core competencies of:
  - visualisation, as a platform for comprehension;
  - mental strategies, to develop decision making abilities;
  - pattern recognition, to support the ability to make connections and generalise.
- Emphasis on the foundations for learning and not on the content itself so students learn to "think mathematically" as opposed to merely following procedures.

Maths No Problem

What can we learn from this approach and how can we apply it to teaching GCSE maths re-sit classes?

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03

MASTERY

Mastery

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UK election world sport football opinion culture business lifestyle fash

home

Teacher Network School leadership and management

Differentiation is out. Mastery is the new classroom buzzword

A dose of eastern-inspired mastery has entered schools. Roy Blatchford discusses the new approach and how could it affect learning

The Guardian: Roy Blatchford: 1/10/2015

Mastery

Approaches to differentiation often divide learners into ‘mathematically weak’ and ‘mathematically able’.

Mastery

The ‘mathematically weak’

- Are aware they are being given less demanding tasks so have a fixed ‘I’m no good at maths’ mind-set.
- They miss out on some of the curriculum so access to the knowledge and understanding they need to progress is restricted. They fall further behind which reinforces their negative view of maths.
- Being challenged (at an appropriate level) is a vital part of learning.
    - If they are not challenged learners can get used to not thinking hard about ideas and persevering to achieve success.

Mastery

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The ‘mathematically able (or gifted)’

- Are often given unfocused extension work that may result in superficial learning.
  - Procedural fluency and a deep understanding of concepts need to be developed in parallel to enable connections to be made between mathematical ideas.
- May be unwilling to tackle more demanding maths because they don’t want to challenge their perception of themselves as ‘clever’.
  - Learners learn most from their mistakes so need to be given difficult, challenging work.
  - Dweck says that you should not praise learners for being ‘clever’ when they succeed but should instead praise them for working hard. They will then associate achievement with effort not cleverness.

Watch Rethinking Giftedness

Mastery

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An approach based on mastery

- Does not differentiate by restricting the maths that ‘weaker’ learners experience.
- All learners are exposed to the same curriculum content at the same pace.
- Focuses on developing deep understanding and secure fluency.
- Shifts the focus from “quantity” to “quality”.
- Provides differentiation by offering rapid support and intervention to address each learner’s needs.

Mastery

Teaching to 'mastery' is a key component of high performing education systems (e.g. Singapore, Japan, South Korea, China).

"Teach Less, Learn More" (Singapore).

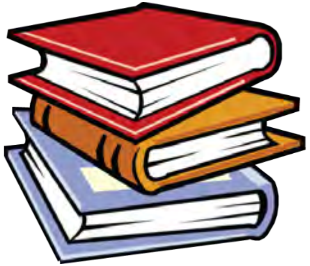
England-China Mathematics Education Innovation Research Project.

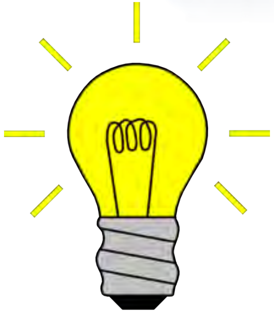
Extract the key features of 'Shanghai' maths from the handout you have read.

Each group to produce a bullet-point list.

MASTERY MYTHS

National Association of Mathematics Advisers





MASTERY

A piece of mathematics has been mastered when it can be used to form a foundation for further mathematical learning: MEI (2015)

MASTERY

A mathematical concept or skill has been mastered when a person can **represent** it in multiple ways, has the mathematical language to **communicate** related ideas, and can independently **apply** the concept to new **problems** in unfamiliar situations.

https://www.mathematicsmastery.org/our-approach/

Mastery

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"Mastery of maths means a deep, long-term, secure and adaptable understanding of the subject. Among the by-products of developing mastery, and to a degree part of the process, are a number of elements:

- ***fluency** (rapid and accurate recall and application of facts and concepts)*
- *a growing confidence to **reason** mathematically*
- *the ability to apply maths to **solve problems**, to conjecture and to test hypotheses".*

NCETM Mastery Microsite

MASTERY

‘Students can be said to have **confidence** and **competence** with mathematical content when they can apply it flexibly to **solve problems**.’

DfE (2013) Mathematics subject content and assessment objectives

Is ‘mastery’ another way of saying ‘confidence and competence’?

What can we learn from this approach and how can we apply it to teaching GCSE maths re-sit classes?

Foundation or Higher tier?

04

RME

Realistic Maths Education (Netherlands)

Learners develop mathematical understanding by working in contexts that make sense to them (not necessarily real-world but ones that can be imagined i.e. ‘realistic’).

Initially they construct their own intuitive methods for solving problems.

They then generalise and develop a more sophisticated and formal understanding supported by well-designed text-books, carefully chosen examples and teacher interventions.

Realistic Maths Education

Less emphasis on algorithms.
More emphasis on understanding and problem solving.
‘Guided reinvention’.
– Teacher uses ‘realistic’ materials to guide learners
Use of models to represent contextual situation
– Bridge the gap between informal and formal methods.

REALISTIC MATHS EDUCATION

Shown here are some of the displays of goods that can be seen at a local market. In each case, write down how many items you think there are in the display. Also write down whether you think each answer is exact or an estimate.

An example of RME-based materials relating to volume.

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05

CONTEXT

Making Sense of Maths

“Math in Context”
– Based on Realistic Maths Education.
– University of Wisconsin (USA).
“Making Sense of Maths”
– Based on Maths in Context.
– Manchester Metropolitan University in conjunction with Freudenthal Institute (Netherlands) and Mathematics in Education and Industry (MEI) in the UK.

MAKING SENSE OF MATHS

Water is sold in packs of 6 bottles. Last week the canteen at Woodhill Sports Club had 39 packs in stock to sell. There are different ways to find the number of bottles in 39 packs.

a. Describe a way to estimate the answer.

b. Adjust your estimate to find an exact answer.

Another way to find an exact answer is to use a ratio table.

Packages	1	10	20	40	39
Bottles	6	60	120	240	234

Making Sense of Maths

Look at sample chapter “All things equal” [available from https://www.hoddereducation.co.uk/makingsenseofmaths]

The chapter starts with the context of a see-saw to introduce the concept of balance.

Progresses to solving linear equations.

Note that there is a deliberate avoidance of showing a standard procedure for solving equations.

Learners develop their own strategies for solving problems first.

Ratio tables

Ratio tables are used frequently and can be used to solve different types of problems.

Multiplication (23 x 46)

1	10	20	3	23
46	460	920	138	1058

Ratio tables

Percentages. The cost of a train ticket from Slough to London Paddington is £8.50. The cost is to be increased by 4%. What will the new train fare be?

4% of 850p is 34p so the new fare will be 850p + 34p = 884p or £8.84.

Cost (in pence)	850	85	8.5	17	34
Percentage	100	10	1	2	4

At the Chip Shop

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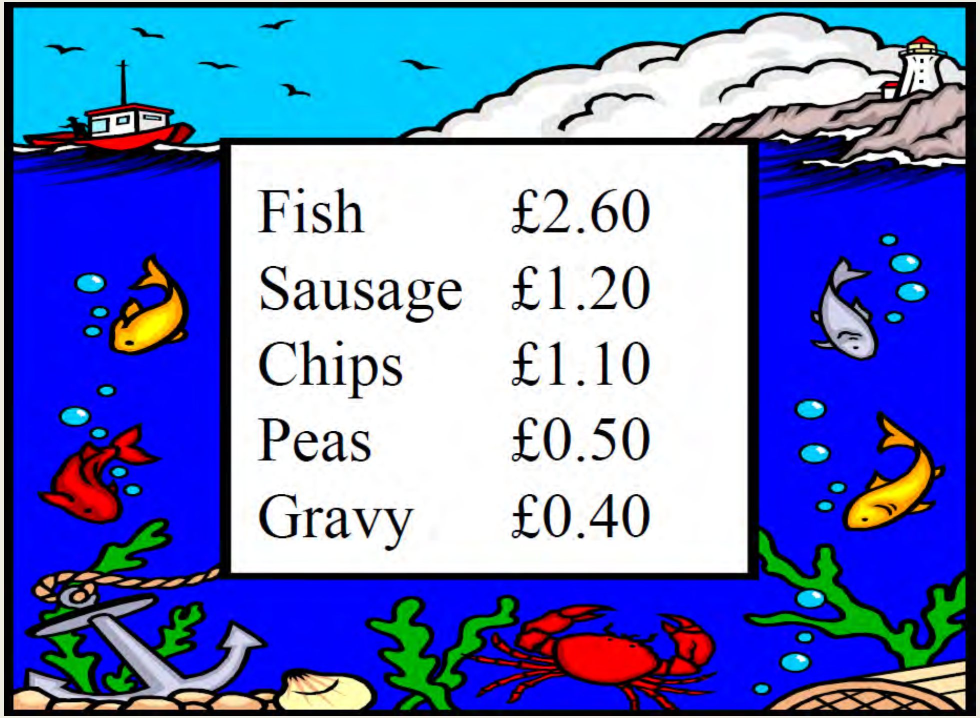

AT THE CHIP SHOP

How much would it cost for fish and chips 3 times?

At the Chip Shop

At lunchtime, people sometimes telephone in big orders. Why do you think this is?

One lunchtime, an order is fish and chips 3 times, sausage and chips twice, fish and peas twice, and 2 extra portions of chips

At the Chip Shop

$3(f+c) + 2(s+c) + 2(f+p) + 2c.$

Made simpler

$3(f+c) + 2(s+c) + 2(f+p) + 2c =$

$3f + 3c + 2s + 2c + 2f + 2p + 2c =$

$5f + 2s + 7c + 2p$

At the Chip Shop

Simplify

$2(s+c) + 3\ (f+p) + 3(f+c) + 2p + 3c + 2s$

$2(f+c+g) + 2(f+c) + f + 3(s+c+p) + (s+c) + 2(c+g) + 3c$

$5(s+c+g) + (f+c) + 2(f+c+p+g) + 3(f+c+g) + 2s + 2c$

At the Chip Shop

Sometimes, people phone through an order, then ring up a bit later and change it.

One day, Claire looked at John's notepad and saw $3(f+c)$ She came back to check it a few minutes later and saw that now on the notepad was $3(f+c) - (f+c)$

What do you think has happened here?

What should Claire wrap up for the customer?

At the Chip Shop

On another occasion, Claire saw on John’s pad $3(f+c) – f + c$

Is this the same?

What do you think $5(s+c+g)$ - $2(s+c)$ means?

What is the simplified order here?

At the Chip Shop

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Remember that when we say '3 fish' we are actually talking about the <u>cost</u> of 3 fish.			
Expanded form	**How to say it in expanded form**	**Factorised form**	**How to say it in factorised form**
3f + 3c	3 fish and 3 chips	3(f + c)	3 lots of fish and chips (or fish and chips 3 times)
2f + 2c + 2p		2(f + c + p)	
6f + 3c + 3p			
		3(3f + 2c)	
2f + 4c + 2p			

What can we learn from this approach and how can we apply it to teaching GCSE maths re-sit classes?

For more information about RME -

MEI (Realistic Mathematics Education)

06

LESSON STUDY

Lesson Study (Japan)

- Teachers collaborate with one another to discuss learning goals and plan a ‘research lesson’. They then observe how their ideas work with students and report on the results so that other teachers can benefit from it.

Burghes, D. & Robinson, D. (2009) Lesson Study: Enhancing Mathematics Teaching and Learning, London: CfBT.
NCETM, (2013) Professional Learning – Lesson Study (online).

Lesson Study (Japan)

Collaboratively plan a lesson.
One participant delivers the lesson, one or more others observe.
Reflect together on the effectiveness of the lesson.
Revise the lesson if necessary.
A different participant delivers the lesson to a different group and others observe.
Report back findings.

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Review of the day

[redacted]

Summary

Self-assess against the objectives for the session.

LEARNING OUTCOMES

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Can you …

Explain how some countries have been able to improve the maths performance of their learners?

Discuss how teaching approaches used in some other countries could be applied to teaching GCSE maths?

Summary

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What common factors are there in the various approaches we have looked at in this session?

Which approaches could be applied to GCSE maths re-sit classes?

How will you apply this in your teaching & learning?

Follow-up activities

Recommended reading

- Skemp, R. R. (1976) *Relational understanding and instrumental understanding*. Mathematics Teaching, 77: 20–6.
- Explore Maths No Problem (2014) *Singapore Maths* [available at http://www.mathsnoproblem.co.uk/singapore-maths]
- NCETM Mastery microsite https://www.ncetm.org.uk/resources/47230
- MEI (2014) *Realistic Mathematics Education*, [available at http://www.mei.org.uk/rme]

Further reading
(for those pursuing accreditation)

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- Cockcroft, W.H. (1982) *Mathematics Counts: Report of the Committee of Inquiry into the Teaching of Mathematics in Schools*. London: HMSO [available at http://www.educationengland.org.uk/documents/cockcroft/cockcroft1982.html].
- Bruner, J.S. (1966) *Toward a Theory of Instruction.* Cambridge, MA: Harvard University Press.
- Dienes, Z. (1960). *Building Up Mathematics* (4th edition). London: Hutchinson Educational Ltd.
- OECD (2016) *PISA results in focus.* [available at https://www.oecd.org/pisa/pisa-2015-results-in-focus.pdf].
- The Research Base (2014) *Effective Practices in Post-16 Vocational Maths: Final Report*. London: The Education and Training Foundation. [available at http://www.et-foundation.co.uk/wp-content/uploads/2014/12/Effective-Practices-in-Post-16-Vocational-Maths-v4-0.pdf].

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THANK YOU
ANY QUESTIONS?