



Education  
Scotland  
Foghlam Alba

# Supporting Student's Learning of Mathematics

Lorna Harvey  
16.11.16

Transforming lives through learning

# Session Aims

## Supporting Student's Learning of Mathematics

- Scotland's Curriculum for Excellence
- Effective learning, teaching and assessment
- Attitudes to mathematics
- Class groupings and differentiation
- Education Scotland

**UK Government**

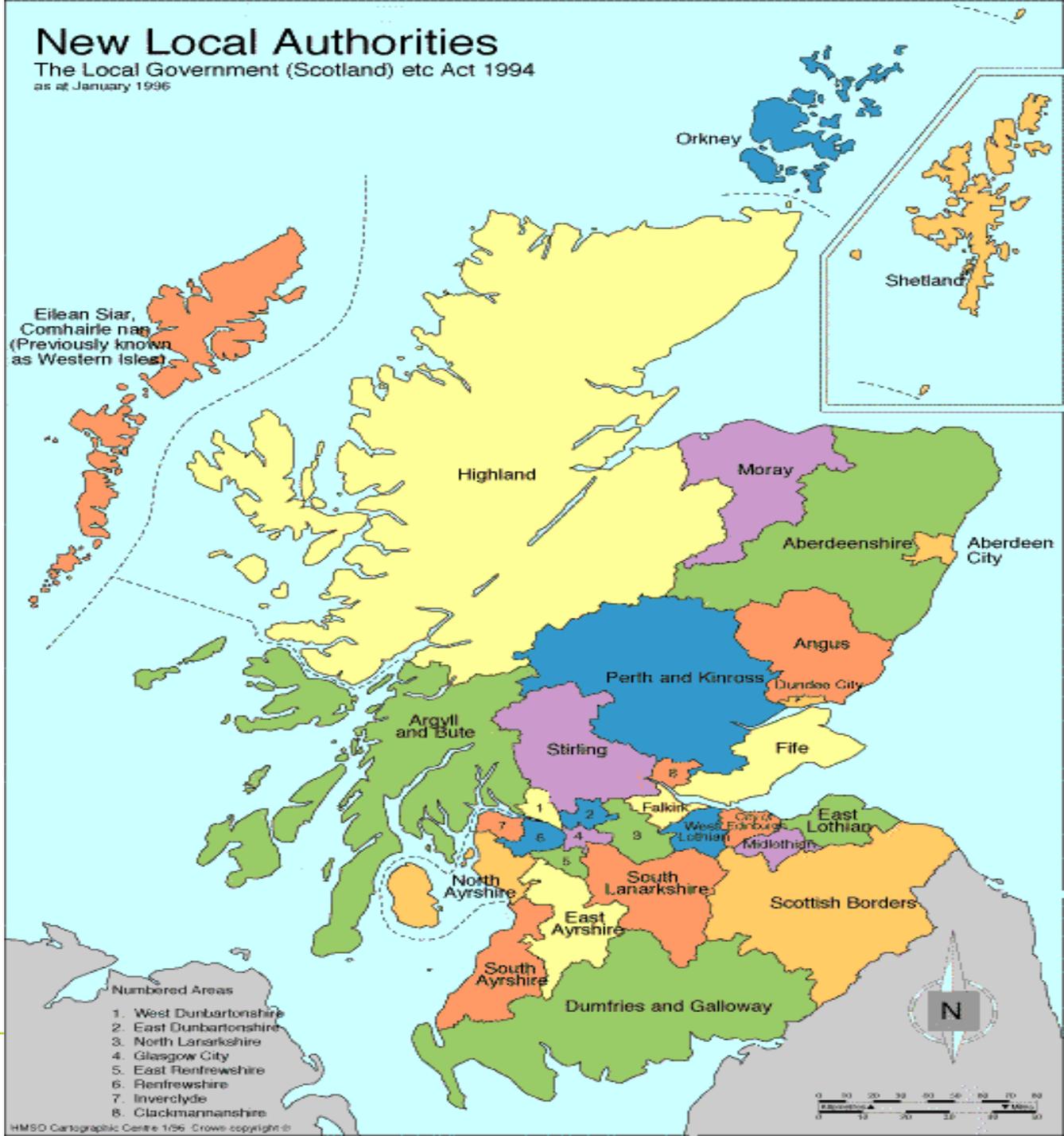


**Scottish Parliament**

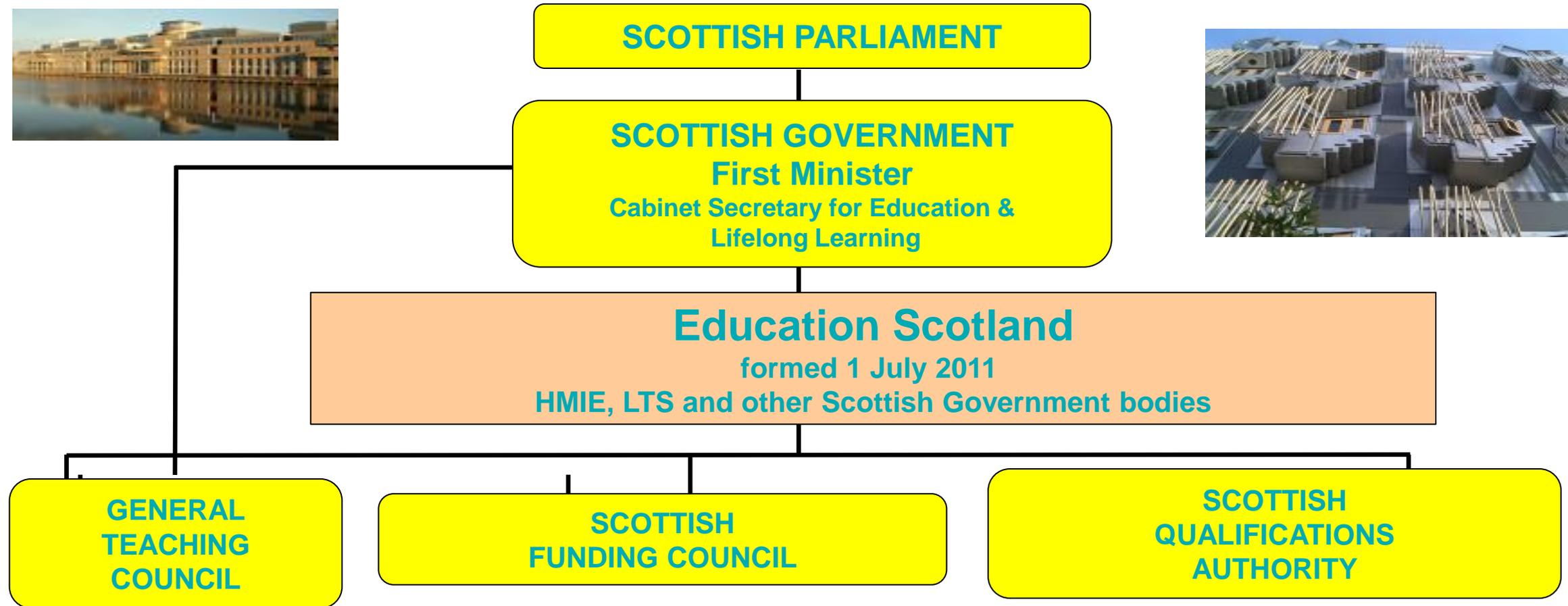


**32**

**Local Councils**



# KEY NATIONAL BODIES INVOLVED IN SCOTTISH EDUCATION



# Curriculum for Excellence

- Curriculum for Excellence (CfE) is the curriculum in Scotland which applies to all children and young people age 3-18, wherever they are learning.
- It aims to raise achievement for all, enabling young people to develop the skills, knowledge and understanding they need to succeed in learning, life and work.

# Curriculum for Excellence

## The Four Capacities

The curriculum aims for all children to become:

- Successful Learners
- Confident Individuals
- Responsible Citizens
- Effective Contributors

## The Seven Principles of Curriculum Design

All learning must take account of these principles:

- Challenge and enjoyment
- Breadth
- Progression
- Depth
- Personalisation and choice
- Coherence
- Relevance

# The Eight Curriculum Areas

Containing a range of subjects:

- Expressive Arts
- Health and Wellbeing
- Languages
- **Mathematics**
- Religious and Moral Education
- Sciences
- Social Studies
- Technologies

## Mathematics

Mathematics equips us with the skills we need to interpret and analyse information, simplify and solve problems, assess risk and make informed decisions.



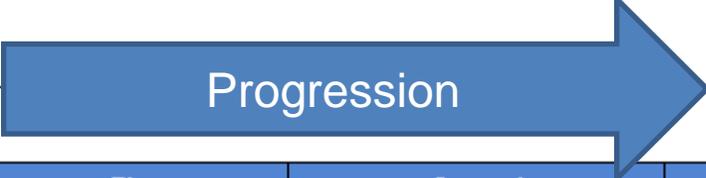
# Learning across the Curriculum

## Responsibility of All

- Literacy
- Numeracy
- Health and Wellbeing

## Themes across Learning

- Creativity
- Enterprise
- Global Citizenship
- Learning for Sustainability
- Financial Education

Information handling					
Progression 					
	Early	First	Second	Third	Fourth
<b>Data and analysis</b>	<p><i>I can collect objects and ask questions to gather information, organising and displaying my findings in different ways.</i> <b>MNU 0-20a</b></p> <p><i>I can match objects, and sort using my own and others' criteria, sharing my ideas with others.</i> <b>MNU 0-20b</b></p> <p><i>I can use the signs and charts around me for information, helping me plan and make choices and decisions in my daily life.</i> <b>MNU 0-20c</b></p>	<p><i>I have explored a variety of ways in which data is presented and can ask and answer questions about the information it contains.</i> <b>MNU 1-20a</b></p> <p><i>I have used a range of ways to collect information and can sort it in a logical, organised and imaginative way using my own and others' criteria.</i> <b>MNU 1-20b</b></p>	<p><i>Having discussed the variety of ways and range of media used to present data, I can interpret and draw conclusions from the information displayed, recognising that the presentation may be misleading.</i> <b>MNU 2-20a</b></p> <p><i>I have carried out investigations and surveys, devising and using a variety of methods to gather information and have worked with others to collate, organise and communicate the results in an appropriate way.</i> <b>MNU 2-20b</b></p>	<p><i>I can work collaboratively, making appropriate use of technology, to source information presented in a range of ways, interpret what it conveys and discuss whether I believe the information to be robust, vague or misleading.</i> <b>MNU 3-20a</b></p> <p>When analysing information or collecting data of my own, I can use my understanding of how bias may arise and how sample size can affect precision, to ensure that the data allows for fair conclusions to be drawn. <b>MTH 3-20b</b></p>	<p><i>I can evaluate and interpret raw and graphical data using a variety of methods, comment on relationships I observe within the data and communicate my findings to others.</i> <b>MNU 4-20a</b></p> <p>In order to compare numerical information in real-life contexts, I can find the mean, median, mode and range of sets of numbers, decide which type of average is most appropriate to use and discuss how using an alternative type of average could be misleading. <b>MTH 4-20b</b></p>
		<b>Depth</b>	<p>Using technology and other methods, I can display data simply, clearly and accurately by creating tables, charts and diagrams, using simple labelling and scale. <b>MTH 1-21a</b></p>	<p>I can display data in a clear way using a suitable scale, by choosing appropriately from an extended range of tables, charts, diagrams and graphs, making effective use of technology. <b>MTH 2-21a / MTH 3-21a</b></p>	<p>I can select appropriately from a wide range of tables, charts, diagrams and graphs when displaying discrete, continuous or grouped data, clearly communicating the significant features of the data. <b>MTH 4-21a</b></p>

**Personalisation and choice**

**Relevance**

## Curriculum Levels

- Early Level: pre-school to the end of Primary 1
- First Level: to the end of Primary 4
- Second Level: to the end of Primary 7
- Third and Fourth Levels: Secondary 1- Secondary 3

# Mathematics-Principles and Practice

Mathematics is important in everyday life, allowing us to make sense of the world around us and to manage our lives. Using mathematics enables us to model real life situation and make connections and informed predictions. It equips us with the skills we need to interpret and analyse information, simplify and solve problems, assess risk and make informed decisions.

*Mathematics, Principles and Practice Paper*

To face the challenge of the 21<sup>st</sup> century, each young person needs to have confidence in using mathematical skills, and Scotland needs both specialist mathematicians and a highly numerate population.

*Building the Curriculum 1*

# Mathematics

## Number and Number Processes

1. Estimation and Rounding
2. Number and Number Processes
3. Multiples, Factors and Primes
4. Powers and Roots
5. Fractions, Decimal Fractions and Percentages
6. Money
7. Time
8. Measurement
9. Mathematics-It's impact on the world, past, present and future
10. Patterns and Relationships
11. Expressions and Equations

## Shape, Position and Movement

1. Properties of 2D shapes and 3D objects
2. Angle, Symmetry and Transformation

## Information Handling

1. Data and Analysis
2. Ideas of Chance and Uncertainty

# Numeracy across Learning-Principles and Practice

We are numerate if we have developed:

The confidence and competence in using number which will allow individuals to solve problems, analyse information and make informed decisions based on calculations.

*Numeracy across Learning, Principles and Practice Paper*

# Numeracy (Responsibility of All)

- Estimation and Rounding
- Number and Number Processes
- Fractions, Decimal Fractions and Percentages
- Money
- Time
- Measurement
- Data and Analysis
- Ideas of Chance and Uncertainty

# Numeracy and Mathematical Skills:

- Interpret questions
- Select and communicate processes and solutions
- Justify choice of strategy used
- Link mathematical concepts
- Use mathematical vocabulary and notation
- Use mental agility
- Reason algebraically
- Determine the reasonableness of a solution

## Reflective Questions

What does mathematics mean to you?

What does mathematics mean to your learners?

What skills are your learners developing? Do they know?

### Experiences and Outcomes

- I am aware of how friendships are formed and that likes, dislikes, special qualities and needs can influence relationships. HWB 2-4a / HWB 1-4a
- Having identified which calculations are needed, I can solve problems involving whole numbers using a range of methods, sharing my approaches and solutions with others. MW2 2-5a
- I can make notes and organise them to develop my thinking, help others and recall information, explore issues and create new texts, using my own words as appropriate. UT 3-15a / UT 4-15a

**The Learner**  
 Planning together for learning, teaching and assessment

**Learning Intentions**  
 Standards and expectations for planned learning

**Success Criteria**  
 Clear, relevant and measurable definitions of success. Learners involved in creating them. In pupil language.

**Learning Experiences**  
 Rich activities planned to take account of the Es and Os and the design principles

**Evidence**  
 A range of appropriate evidence

**Assessment Approaches**  
 Assess: Progress.  
 Assess: Breadth, challenge, application

### Principle Practi

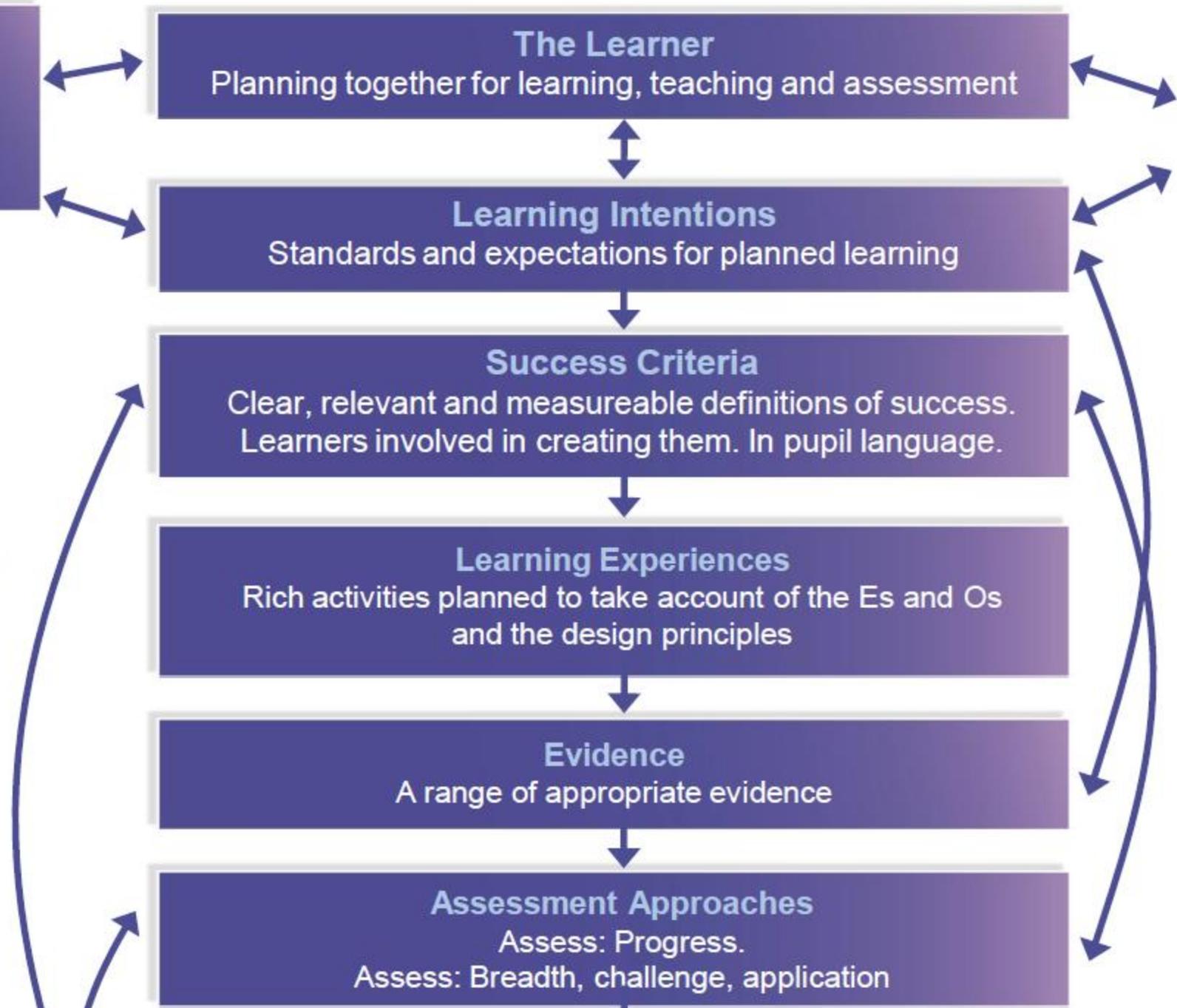
Ensure **evidence** reflects **Learning Intentions**

Ensure **assessment approaches** are on **success cr**

## NAR Flowchart

Refer to 'Using the NAR Flow Chart – Step by Step Instructions' guidance notes

**Feedback and next steps** should relate directly to **success**



# A numeracy/mathematically rich environment

- Stimulating
- Celebration
- Confident learners
- Talking about learning
- Challenge and enjoyment
- Breadth
- Progression
- Depth
- Personalisation and choice
- Coherence
- Relevance

# The Scottish Education Awards

- 2014            Secondary school            Numeracy across learning
- 2015            Primary school                Mental agility
- 2016            Early Years Centre            Raising attainment



# Characteristics of effective learning

- Visible learning
  - Collection of evidence
  - Interventions
  - Impact
- "Visible learning is teachers seeing learning through the eyes of their students, and students seeing themselves as their own teachers."
  - Good Learner Video, Pupil Focus Groups, Learning Walkthrough
  - 7 whole school focus areas (use of mistakes, learner profile, learning intentions and success criteria, feedback, emphasis on how learners are learning and building the concept of teachers as evaluators
  - Raised attainment (in mathematics) and attitudes to both mathematics and to learning in general.

# Before and after the interventions

- I'm scared to put up my hand in case I am wrong
  - Sitting at the back is better, because no-one notices your mistakes
  - People who are good at learning get everything right
- 
- End of key stage 1 Level 2B+ improved by 19% in mathematics
  - End of key stage 2 Level 4+ had improved by 19% in mathematics

# Learning from mistakes

- Teachers highlight their favourite mistake-conceptual rather than numerical errors
- Publicly value mistakes in class
- Provide positive messages about mistakes during one-to-one interactions
- Opportunities for learners to explain their work (reasoning) is central to the discipline of mathematics

# Positive attitudes to mathematics

## Foreward by Carol Dweck

“How can we help teachers and children believe that maths ability can be developed, and then show teachers how to teach maths in a way that brings this belief to life?”

## Mathematical Mindsets by Jo Boaler

“Approaching mathematics conceptually is the essence of what I describe as a mathematical mindset.”

# Learning Superheroes To Promote Positive Growth Mindsets

Curious Kevin



Learning Lola



Tim the Team Player



Tough Tina



Practising Pete



Mike the Mistake Maker



Colin Concentration



Imogen Imagination



# Setting up positive norms in the maths class

## Jo Boaler

Everyone can learn maths to the highest level

Mistakes are valuable

Questions are really important

Depth is more important than speed

Maths class is about learning not performing

Maths is about connections and communicating

Maths is about creativity and making sense

# Rich Mathematical Tasks and Active Learning

Four 4's

Can you find every number between 1 and 20 using only four 4's and any operation?

## Reflective Questions

How can you create rich tasks which promote enquiry?

How can learners become involved in creating rich tasks?

## Class groupings and differentiation

- Ability groupings v set groupings
- Differentiation

# Class Groupings

## Set Groups

- Low expectations
- Lower level work
- Too fast
- Pressure to perform

“In situations where students who struggle are placed with other students who struggle, they do not come into contact with high-level discussions and the bar is kept at a low standard for everyone.”

Jo Boaler, 2015

## Mixed Ability Groups

- Students leading learning by explaining strategies to others
- Explaining work helps to deepen own understanding
- Explaining work can help to identify misconceptions
- Communication skills enhanced
- Open ended rich tasks
- Challenge

# Differentiated Learning in Numeracy and Mathematics

## Briefing published by Education Scotland

- Flexible grouping
- Ongoing assessment
- Variety of daily numeracy activities that vary in complexity and open-endedness

“To meet the diverse needs of all children, teachers can also use interest or learning centres (i.e. where similar materials are grouped together to encourage specific activities and experiences) or using anchor activities (i.e. tasks related to the current topic, which children work on independently.)”

Cox, 2008

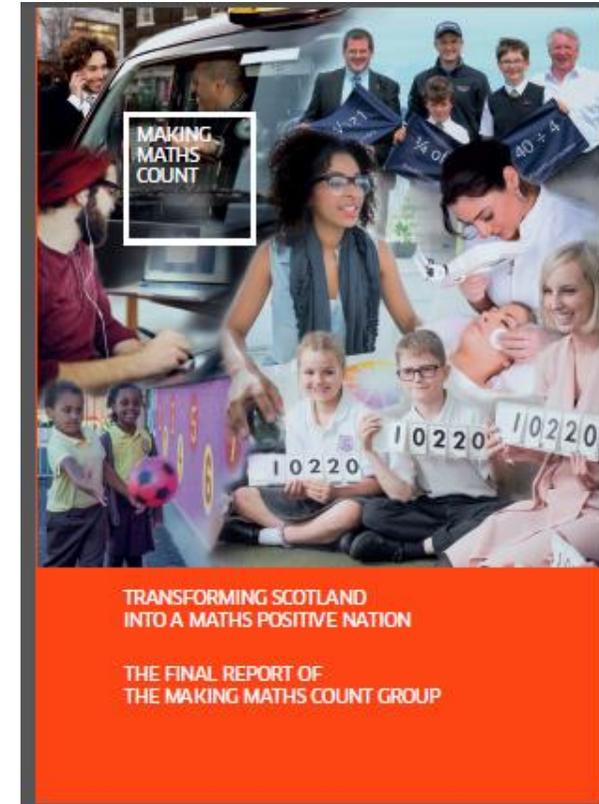
# Education Scotland

- Making Maths Count
- Read Write Count
- National Numeracy and Mathematics Progression Framework
- National Numeracy and Mathematics Hub

# Making Maths Count

Aims:

1. Raise the profile of mathematics
2. Support national qualifications in mathematics-  
National Mathematics  
Development Group



**READ  
WRITE  
COUNT** Together  
it's fun



# Read, Write, Count

a campaign to provide advice and materials to families to help **raise attainment for all** and to **close the attainment gap**

**[www.readwritecount.scot](http://www.readwritecount.scot)**

## Read, Write, Count elements (1)

- **Social marketing** – website, advertising, social media, PR, working with partners (public / private / third sector)
  - Focuses on giving advice on little ways to include learning in everyday life, for example, counting out money at the shops, reading bedtime stories and writing shopping lists
  - Emphasis is on idea that small things make a big difference
- **Libraries** – promoting libraries as a space for family learning and encouraging membership

# Primary 2 Bag

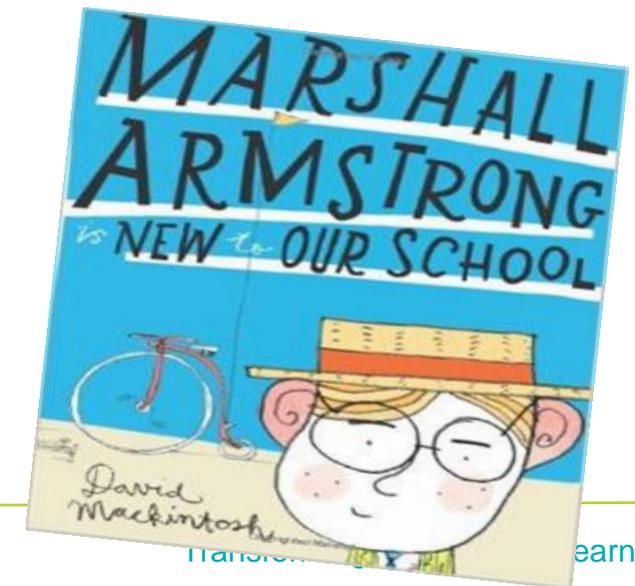
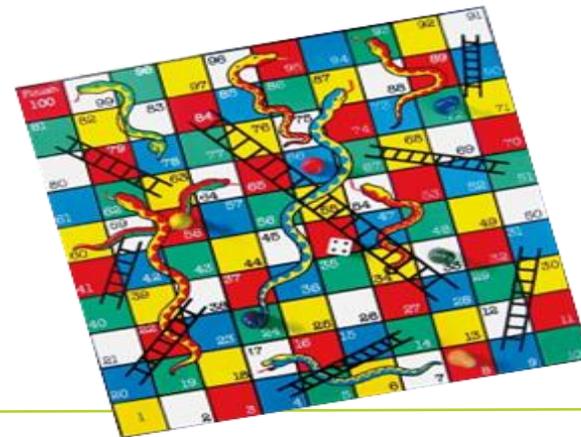
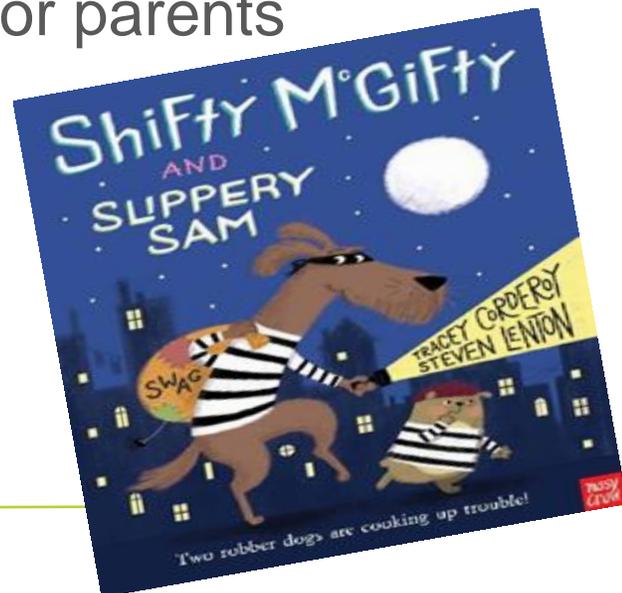
Two picture books

Snakes and Ladders board game

Finger puppets

Notebook, writing pencil and coloured pencils

Guide for parents



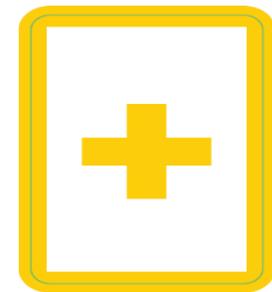
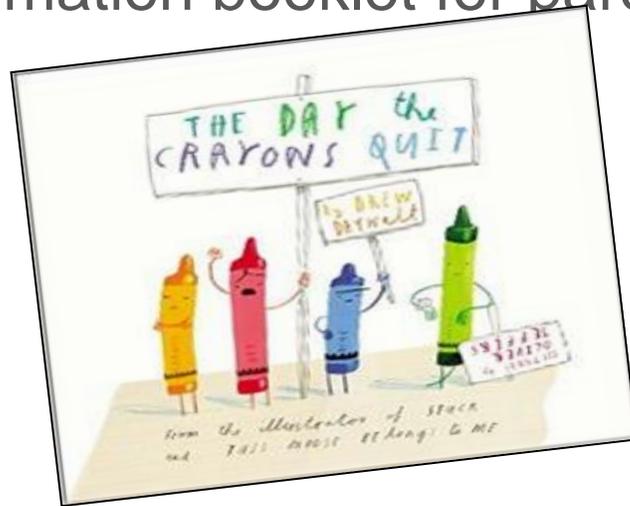
# Primary 3 Bags

Two picture books

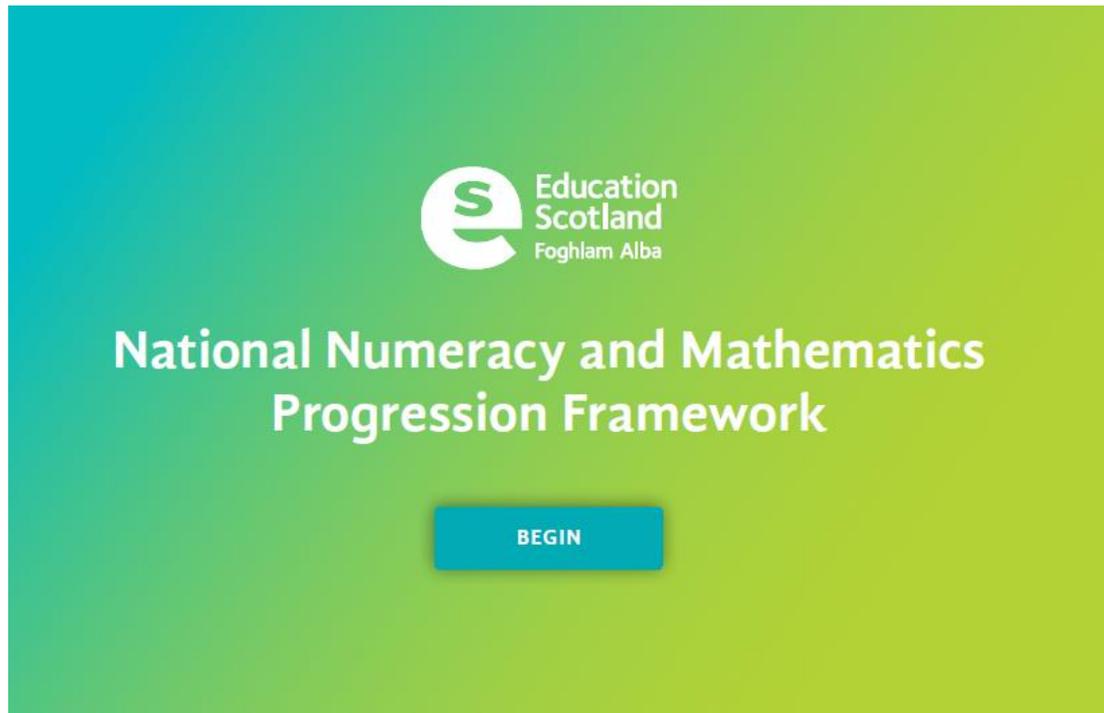
Number playing cards

Notebook, writing pencil and coloured pencils

Information booklet for parents

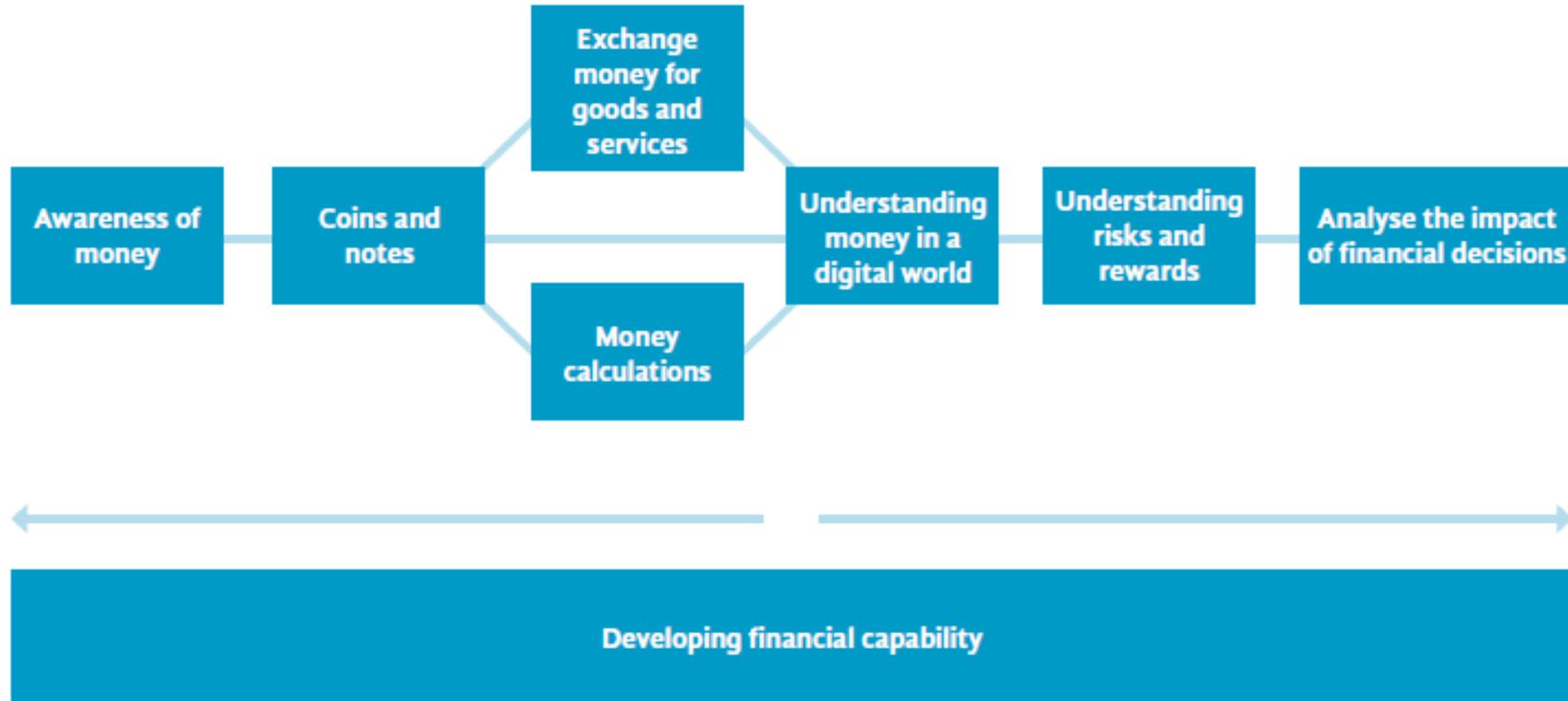


# The National Numeracy and Mathematics Progression Framework



- To support understanding of progression
- Key milestones and building blocks
- Numeracy and mathematics organisers are not taught in isolation from each other and knowledge in one organiser may be required to progress in other organisers.

# Money





## Understanding money in a digital world

### Why is it important?

The increased variety of methods of payment has changed money from a concrete to a more abstract concept.

Understanding  
money in a digital  
world

Online shopping

Online banking

Best value

Developing financial capability

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### Online shopping

#### What Is It?

Using cards to make payments for goods online. Making comparisons between different websites and shops.

#### Previous knowledge and understanding

- Use a range of strategies add/subtract/multiply and divide numbers to 2 decimal places to compare costs

Understanding  
money in a digital  
world

Online shopping

Online banking

Best value

Analys  
of finan

Developing financial capability

## How can the NNMPF be used?

- To inform planning for effective learning and teaching
- To identify progress made and next steps
- To ensure there are no gaps in learning-prior learning and consolidation
- To exemplify effective learning and teaching approaches for number and number processes
- To develop practitioner knowledge and understanding



# National Numeracy and Mathematics Hub

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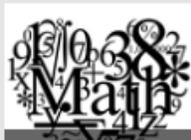
Research



Anytime Learning



National Support  
Events



Numeracy/Mathematics  
Resources



National Improvement  
Hub

## Benchmarks

We encourage you and your colleagues to provide feedback on how you are using the Benchmarks as well as specific feedback and suggestions on any of the Benchmarks. Please use the link below:

[Delivering excellence and equity in Scottish education: A delivery plan](#)

Our collegiate conversations are now on Yammer. More information here [Handy guide - From Newsfeed to Yammer](#) (closed)

### Numeracy & Mathematics conversation

#### Glow Yammer



Please post your message in a specific group.



**Con Morris** – October 27 at 8:36am



**John Sexton**  
In WL Digilearn

An exciting morning tomorrow supporting the West Lothian Scottish Mathematical Council Enterprising Maths regional heat. Follow all the action and feel free to comment on the WL Enterprising Maths Competition 2016 group.

[View Full Conversation](#)

 4

 LIKE  REPLY [VIEW CONVERSATION](#)

All Company



**Miss Welsh** – October 7 at 2:42pm

Can anyone recommend good resources for Advanced Higher Maths of Mechanics? I have a few PDFs of textbooks from the old Mechanics course but struggling to find much else.

Any help will be most appreciated!

 LIKE  REPLY  SHARE ...

 1 share



**Edwin Irvine** – October 25 at 2:04pm

Hello, I am currently developing this course with another colleague in our school and we have been using Understanding Mechanics (A.J. Sadler, D.w.S Thorning, Oxford University Press, ISBN: 0-19-914675-6) mainly. We have made use of the SQA support notes for the new course, to identify relevant chapters. We in the process of putting together a plan and noting down any good web links/videos, other resources, I can forward you this if you would like it (email: [edwin.irvine@shetland.gov.uk](mailto:edwin.irvine@shetland.gov.uk)) but it is still very much a work in progress! We quite like the Understanding Mechanics textbook, it provides plenty of graded examples. Depending on what the student has done previously in Higher physics (and maths), we select questions as appropriate. There is scope for extending more able pupils too in this textbook, for example pulley systems which is a useful extension but not assessed in the course, or projection from an inclined plane.

 LIKE  REPLY  SHARE ...

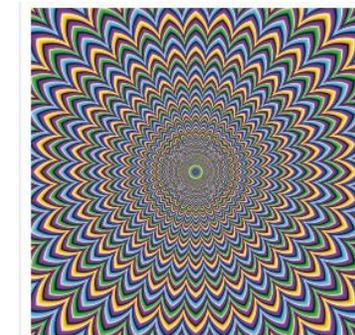
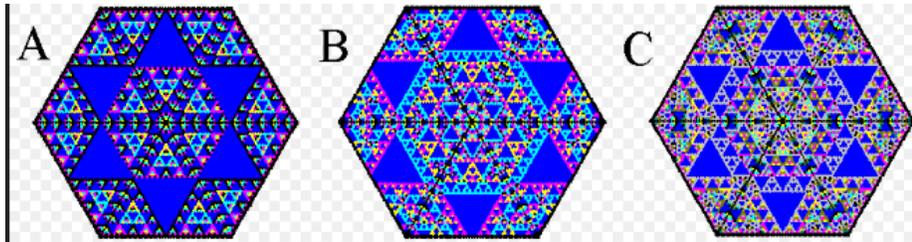
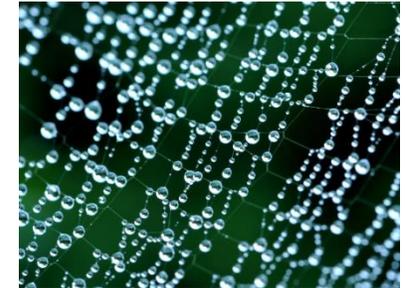
Neil McCafferty (Glow O365 PM) and John Sexton like this



Write a reply



# Some of the reasons why I love mathematics



OPTICAL ART TASK

- Generalization
- Number Sense
- Pattern Recognition
- Shape and Space

**Treble 20**



**180**

**Double 19**

**501**

**Thank you for your participation**

**Lorna Harvey**

**Senior Education Officer**

**Numeracy and Mathematics**