Primary & Early Years Magazine 81

National Centre for Excellence in the Teaching of Mathematics

Welcome to another issue of our Primary Magazine, which has now been serving primary teachers for 80 issues with a varied collection of articles related to maths education and mathematics professional development - all of which are accessible through the Primary Magazine Archive.

Contents

This month we have the first of three articles which look at assessing the aims of the National Curriculum, starting with fluency.

Maths in the Staff Room suggests ways in which collective teacher discussions - both formal and informal - can form part of the ongoing process of professional learning, and help increase the effectiveness of maths teaching across the school. This month's article follows on from last month's and considers how a key mathematical structure, 'doing and undoing', has relevance across the curriculum.

Seen and Heard provides a specific example of a child's response to mathematics in a classroom to stimulate thinking and provoke questions about how you would react to similar events in your own classroom. This month a Year 3 pupil makes us think about what children understand about quarters.

If you have a photograph, or an account of a classroom conversation, that might stimulate similar thought, please email it to us. If we publish your suggestion, we'll put a £20 voucher in the post.

But first, we have a News section, bringing news from the NCETM and beyond to keep you up to date with the fast-changing world of mathematics education.

News

Maths Festival at Science Museum

Billed as an interactive festival of maths, What's Your Angle: Uncovering Maths, runs at the Science Museum in London for four days at the end of November, with one day (27 November) earmarked for school visits only. The idea is to invite visitors to become undercover reporters and investigate the creative and practical ways that researchers are currently using mathematics to solve problems and change lives. The free event is being held in partnership with the London Mathematical Society in celebration of their 150th Anniversary.

Primary Mathematics Challenge

There's still just about time for your school to participate in the Primary Mathematics Challenge (PMC) run by the Mathematical Association, which this year takes place in the week beginning 16 November. The challenge, aimed at year 5 and 6 pupils, provides an opportunity to tackle a wide variety of problems in just 45 minutes. For more information and to enter your school visit the PMC website.

Primary mathematics calculation guidance

Have you seen our new Calculation Guidance for Primary Schools, put together by the NCETM and teachers from primary schools taking part in the England-China project within the Maths Hubs programme? Since publication in the second week of October, it has been downloaded more than 13 000 times. It offers illustrated practice guidance, with examples, of how the teaching and learning of calculation can help pupils acquire deep and lasting understanding of mathematics.

Developing Primary Professional Development Leads

A number of Maths Hubs are running programmes, this term and next, to develop primary teachers into leaders of maths specific professional development, what we call PD Leads. The courses involve two or three, separated days out of school, with interim tasks to complete. Find out more here.

National Curriculum in Focus

National Curriculum in Focus *is dedicated to unpicking the new curriculum and how to understand and develop the requirements of the new programmes of study for mathematics. You can find previous features in this series here*

Assessing the Aims: Part One - Fluency

This is the first of three articles focused on assessment of the aims of the National Curriculum

The National Curriculum for mathematics aims to ensure that all pupils:

- become fluent in the fundamentals of mathematics, including through varied and frequent practice with increasingly complex problems over time, so that pupils develop conceptual understanding and the ability to recall and apply knowledge rapidly and accurately
- reason mathematically by following a line of enquiry, conjecturing relationships and generalisations, and developing an argument, justification or proof using mathematical language
- can solve problems by applying their mathematics to a variety of routine and non-routine problems with increasing sophistication, including breaking down problems into a series of simpler steps and persevering in seeking solutions"[1]

As stated in the NCETM Teaching for Mastery booklets:

> *"Progress in mathematics learning each year should be assessed according to the extent to which pupils are gaining a deep understanding of the content taught for that year, resulting in sustainable knowledge and skills. Key measures of this are the abilities to reason mathematically and to solve increasingly complex problems, doing so with fluency, as described in the aims of the National Curriculum."*[2]

As teachers and schools grapple with decisions about assessment it will be important for them to consider how the aims are reflected in their:

- assessment principles
- assessment criteria, and
- assessment practice.

The first of the aims, fluency, involves pupils making and justifying decisions and using what they know and understand to solve problems. Making decisions requires pausing before engaging with 'doing' the maths.

The need to pause before engaging with solving any problem is necessary in order to provide the opportunity to notice things. This is an important element of fluency which is not always appreciated by children. Noticing is crucial to good decision-making.

It is possible for children to get correct solutions without making good decisions; for example: in Year 2, calculating 40 + 8 by counting in ones, in Year 4 calculating 1003 - 998 using a formal written method; and

in Year 6 calculating 41.79 + 25.3 + 25.7 – 41.79 by adding the first three numbers and then subtracting the fourth. Accuracy alone does not indicate fluency.

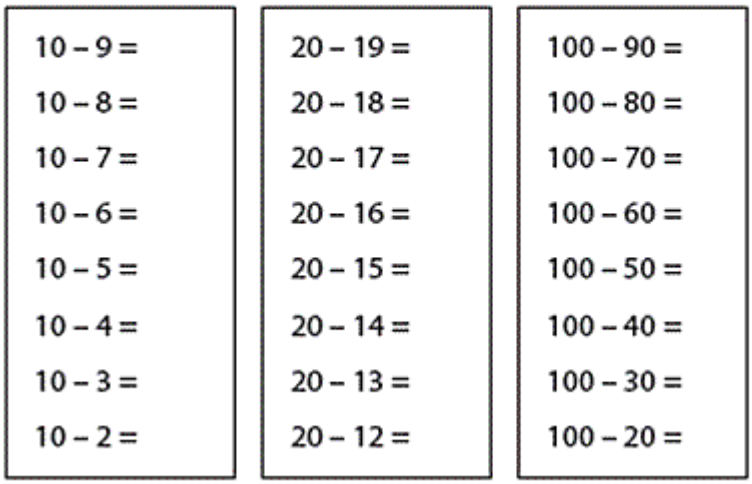
Assessment of fluency must, therefore, be more than assessment of children successfully 'doing' some maths and getting correct answers; it should include assessing whether children take a flexible approach and make appropriate decisions, based on what they notice and what they already know and understand.

Providing opportunities for children to focus on decision making can be achieved in a number of ways; the following suggestions are illustrated with examples from the Teaching for Mastery booklets:

- Making a direct connection between known facts and related calculations

  What do you notice about each set of calculations?

  What's the same and what's different about the three sets of calculations?



10 – 9 =	20 – 19 =	100 – 90 =
10 – 8 =	20 – 18 =	100 – 80 =
10 – 7 =	20 – 17 =	100 – 70 =
10 – 6 =	20 – 16 =	100 – 60 =
10 – 5 =	20 – 15 =	100 – 50 =
10 – 4 =	20 – 14 =	100 – 40 =
10 – 3 =	20 – 13 =	100 – 30 =
10 – 2 =	20 – 12 =	100 – 20 =

  Year 2

  With this example, the children could also be asked to write another set of calculations using the same known facts in order to further probe understanding.

- Comparing different methods and identifying which is most efficient

Ali and Sarah calculate 420 + 221 + 280 using different strategies.

This is Sarah's strategy:	This is Ali's strategy:
420 + 221 + 280 420 + 221 = 641 641 + 280 = 921 Answer = 921	420 + 221 + 280 420 + 280 = 700 700+ 221 = 921 Answer = 921

Which do you prefer?

Explain your reasoning.

Now calculate 370 + 242 + 130 using your preferred strategy.

Year 4

When comparing methods, it is useful to ask children to consider what has been noticed and why this is useful in each method, as well as whether there is a calculation they can think of when the method they have identified as more efficient would no longer be more efficient. It is important that they understand that no one method is going to best for all situations, hence the need to make decisions. For example, a child might suggest that rounding and adjusting is the best way to solve £163 - £28 but this might not be the best choice for £762 - £462.

- Considering how to use a given fact to work out related facts

It is correct that 273 × 32 = 8736. Use this fact to work out:

- 27·3 × 3·2
- 2·73 × 32 000
- 873·6 ÷ 0·32
- 87·36 ÷ 27·3
- 8736 ÷ 16
- 4368 ÷ 1·6

Year 6

This example reflects all three elements of fluency as described below:

"Fluency rests on a well-built mathematical foundation with three parts:

- an understanding of the meaning of the operations and their relationships to each other - for example, the inverse relationship between multiplication and division;
- the knowledge of a large repertoire of number relationships, including the addition and multiplication "facts" as well as other relationships, such as how 4 x 5 is related to 4 x 50;
- a thorough understanding of the base ten number system, how numbers are structured in this system, and how the place value system of numbers behaves in different operations – for example, that 24 + 10 = 34 or 24 x 10 = 240."[3]

- Making a situation easier to deal with

  Work out:

  - $8{\cdot}4 \times 3 + 8{\cdot}4 \times 7$
  - $6{\cdot}7 \times 5 - 0{\cdot}67 \times 50$
  - $93 \times 0{\cdot}2 + 0{\cdot}8 \times 93$
  - $7{\cdot}2 \times 4 + 3{\cdot}6 \times 8$

  Year 6

  Seemingly difficult calculations can often be quite simple when they are viewed as a whole rather than a series of unconnected parts. This can start in KS1 where children should be expected to identify what makes calculations such as 7 + 15 – 7 easy.

Assessing fluency will, therefore, include assessing efficiency, accuracy and flexibility. Embedding this in assessment systems and practices is one of the challenges for schools at this time. Next month we will look at assessing reasoning.

[1] National Curriculum 2014
[2] Teaching for Mastery NCETM 2015
[3] Developing Computational Fluency with Whole Numbers in the Elementary Grades Russell 2000

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Maths in the Staff Room – Short Professional Development Meetings

Maths in the Staff Room *provides suggestions and resources for a professional development meeting for teachers that can be led by the maths subject leader or another person with responsibility for developing mathematics teaching and learning in the school. You can find previous features in this series here*

Understanding key mathematical structures. Part two: 'Doing and undoing' across the curriculum

Last month's magazine contained the first part of looking at 'Doing and undoing', starting in the context of mathematics. This session follows on and assumes the activities in part one have taken place. The two parts could be merged if the introduction to the first part is adapted

Meeting aims

- To consider the importance of structure in mathematics and how it has relevance across the curriculum
- To make explicit opportunities to embed the aims of the National Curriculum both within mathematics and across the curriculum.

Timings

- Ten minutes initial input
- Ten minutes, thirty minutes, sixty minutes or ninety minutes follow up after two weeks.

Resources

- Essentials of Numeracy for All: Being Numerate diagram (from National Numeracy)
- Large sheet of paper from part 1, containing ideas for 'Doing and Undoing' across the mathematics curriculum
- Second large sheet of paper for display in the staffroom with 'Doing and Undoing across the curriculum' in the middle.

Ten minute introduction

1. Explain that you are going to start to explore opportunities for mathematics across the curriculum
2. Share the 'Being Numerate' diagram *(Ctrl+Click to enlarge)*, and read the statement which accompanies it:

'Being numerate' means having the confidence and ability to use the right mathematical tools and processes in everyday life. This involves reasoning, solving problems and making decisions and requires a willingness to persist with different approaches. Say that there are more connections than are shown between the different elements, such as searching for pattern and identifying structure.

3. Suggest that focusing on being numerate across the curriculum - attitudes of mind, problem solving, reasoning and decision making - is one way to embed the aims of the National Curriculum. This is different to trying to cover mathematical content in other subjects. Say that you are focusing on one important structure - doing and undoing - which you have already started to explore in mathematics

4. Remind everyone of the work you have already done, thinking about the mathematical structure of 'Doing and Undoing'. Use the sheet from the previous sessions to revisit ideas that were shared in the earlier meetings

5. Introduce a second sheet with 'Doing and Undoing across the curriculum' written in the middle. Invite everyone to think about this theme across the curriculum over the next two weeks and whenever they notice it, to add it to the sheet, which you will come back to in a future meeting. Suggest that one example of this might be in computing; programming a toy or a sprite to turn clockwise and then back to where it started. Write this on the sheet.

Follow up meeting two weeks later (you may need to prompt people to add to the sheet and model this by adding ideas during the two weeks).

- Have the two large sheets which have ideas connected to 'Doing and Undoing' both from within mathematics and across the curriculum

- Ask: *Are there any more examples of doing and undoing in different subjects that you can think of?* Add these to the sheet. Ask people to explain one of the items in turn. This might prompt further ideas which could include:

  - Science
    - changes of state (heating and cooling)
    - dissolving and recovering a substance from a solution
    - mixing and separating mixtures
    - forces (push and pull)
    - switching off and on in a circuit
    - attracting and repelling.

  - Computing
    - programming movement forward and backwards
    - programming turn.

  - PE
    - movement patterns in dance
    - shape and balance in gymnastics (stretching and returning).

  - Music

    - scales – up and down.

- Design and technology
    - application of science knowledge in mechanical and electrical systems
    - application of computing knowledge in programming products.

- English
    - giving instructions and reversing the instructions
    - blending sounds to read words and segmenting spoken words into phonemes.

- Geography
    - moving between two places using locational and directional language (right, left, forward, backward) or following compass directions (e.g. travel North) and then retuning.

- Languages
    - translating from English to French and then from French to English.

- Choose one idea relevant to your children and discuss how to support understanding.
  Consider:
    - *What might the children physically do to demonstrate this relationship?*
    - *What contexts make sense of the relationship?*
    - *How could it be modelled with different resources/pictures/drawings?*
    - *How could it be recorded?*
    - *What would you want the children to notice and be able to explain?*
    - *What sort of questions would show if the children have understood?*

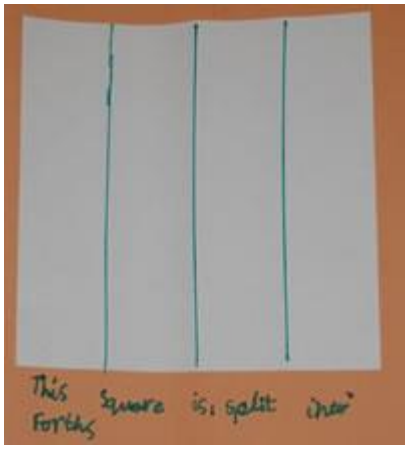
- Ask: *Does undoing what you have done always take you back to where you started?*
  Can you think of any examples where it doesn't or where it can't be easily done?
    - Science - some changes of materials result in the formation of new materials and this kind
    - of change is not usually reversible, e.g. burning
    - Geography - reversing human impact on the environment
    - Design and technology - cooked food cannot be returned to its raw state
    - Languages - some words when translated can have more than one meaning, for example
    - *piano* in Italian

Seen and Heard

Seen and Heard *will shine a light, via photographs and conversations from classrooms, on a specific example of the mathematics learning experience, the aim being to stimulate thought and questions about how you would react to similar events in your own classroom*

During a lesson focussed on fractions, in Y3, one child wrote *(Ctrl+Click to enlarge)*:

This square is split into quarters



This square is split into fourths

- What would you think if a child said this?
- What do they understand about quarters?
- Why are they also using 'fourths'?
- How does their understanding of quarters fit with their understanding of other fractions?
- Why might they think the parts in the two pictures have different 'names'?
- What might you do next to help the child to connect their understanding of quarters with their understanding of unit fractions in general?

If you have a thought-inducing picture, please send a copy (ideally, about 1-2Mb) to us at info@ncetm.org.uk with 'Primary Magazine: Seen and Heard feature' in the email subject line. Include a note of where and when it was taken, and any comments on it you may have. If your picture is published, we'll send you a £20 voucher.