Meeting the challenges of **the new maths curriculum**

Developing problem-solving and reasoning skills lies at the heart of the new primary mathematics curriculum. Such a shift in focus is welcome, but for some, may require a rethink in the way they approach maths teaching. **Tim Handley** offers his advice for schools preparing to take on the challenge.

The 2014 maths curriculum has received a lot of attention from both press and teachers alike, as it represents one of the biggest changes introduced by the new national curriculum. Standards and expectations are much higher than before, and the support offered under the old curriculum is no longer available. This has left many teachers feeling rather panicked and confused about how to best implement the new curriculum.

Despite concerns however, the curriculum stands as it does and we are now expected to teach it. We therefore need to look at how we can approach teaching it so that children gain a solid start to their maths education. But don't panic! With the right approach and support, it is most definitely achievable.

Understanding the aims of the new curriculum

It is vital that teachers read the introduction and aims of the new maths curriculum. In my opinion, this is the crucial part, yet it is a section that is often overlooked by teachers. The aims and introduction provide nearly all of the key ways to get around some of the perceived difficulties of the curriculum.

I would advise that you pay particularly close attention to the aims, as these are central to understanding the objectives of the new programmes of study, which the government has made clear must be present through all maths teaching. However, the aims aren't referenced in the year-by-year content of the curriculum, so it is important that teachers embed the aims through their day-to-day maths teaching.

The aims of the new primary maths curriculum are to ensure 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
- 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.

It is also important to note that one of the messages of the introduction of the curriculum is that teachers are allowed to teach any of the subject content at any point within the relevant key stage. This means, for example, that you don't

have to teach Year 3 content in Year 3 if a student isn't ready for it. A Year 3 objective can be taught at any point in Key Stage 2. The important message is to teach the content when children are conceptually ready for it. Schools need to be receptive to their own students' needs, and every school and every student is different. Children should only be taught a curriculum objective when they are ready to be taught it.

Primary academies also have significantly more freedom than state schools, as they can formulate their own curriculum. However, pupils in primary academies will ultimately be tested on the curriculum content at the end of Key Stages 1 and 2, so it is a good idea for them to broadly follow the new national curriculum, while using their increased flexibility by, for example, removing or replacing elements that they feel their students would not be conceptually ready to study.

Designing your own strategy

It is important to note that the new curriculum has not been given to teachers in a 'pick up and teach' style. During the transition to the new curriculum, teachers also lost the support from the national strategy and national numeracy framework documents that many have been relying upon. This means that without the creation of a school or cluster level programme of study or replacement for the national numeracy strategy, teachers will have no guidance over the priority of objectives, the order in which to teach them or the length of time on which to spend on each strand.

It is therefore vital that something is put in place at a local level in order to support teachers. There are, of course, an increasing number of commercial schemes available – however, schools have to bear in mind that these have not been designed specifically for the children in their school and often just follow the statements in the new curriculum without any modifications. The arguments for and against commercial schemes are for a different article entirely!

Some publishers, including Imaginative Minds, have also published their own framework for leaders in schools to take and adapt to form their own curriculum. Resources like these are a very useful tool as they give schools a starting point, while allowing for a greater level of flexibility and individualised teaching and learning.

However, some schools are also choosing to create their own scheme or strategy entirely, often using either the 1998 strategy or 2006 framework documents as a starting point. No matter which way schools decide to go, it is important that they consider the following key questions in their strategy design:

- **Is there a clear progression and development of each skill area?** The curriculum document itself 'jumps' around, missing out key 'stepping stones' between bigger objectives. For example, doubling and halving shows very little progression in the curriculum documents, yet a secure knowledge of doubling and halving is needed for many of the other objectives. It is also important that areas like algebraic reasoning, which only appears in the curriculum documents in Year 6, are developed throughout Key Stages 1 and 2.
- **Does the order and year group of objectives meet the needs of your children?** As mentioned above, schools can move objectives around within the key stage. So, for example, if you feel that your students will not be conceptually ready for formal algorithms in Years 3 or 4, these can be moved to other year groups. Many schools feel that some curriculum content that exists in Years 5 and 6 could be taught earlier. It all depends on what level your students are at.

- **Are the objectives prioritised?** It is important that the objectives in the curriculum are given appropriate priority. For example, it would be an idea for schools to spend significantly more time on the calculation areas of the curriculum rather than the geometry areas.
- **Are children expected to reason and problem solve?** This is a key aim of the new curriculum and more tips on how to allow children to achieve this aim are provided later in this article.

Prioritising problem solving and reasoning

The aims of the new curriculum put problem solving and reasoning at the heart of mathematics teaching. However, this isn't important simply because it is one of the aims of the new curriculum. It is vital that teaching is rich with opportunities to develop problem solving and reasoning skills in order to enable children to meet the significantly higher content demands of the new curriculum.

It is important that children develop mathematical skills and understand maths, rather than just being able to 'do' maths. To enable students to do this, we need to get them to make connections through problem solving and reasoning. It's crucial that students understand conjectures, spot patterns and the connections between areas of maths and generalisations.

Professor John Mason has identified a set of 8 'mathematical powers' that all children possess, and which we need to foster and develop in order to create able mathematicians who hold the ability to reason about maths and problem solve.

The powers (or if you're looking for an engaging way to present them to the children, 'superpowers') are as follows:

- **Conjecture** – children should be encouraged to make conjectures and say what they think, what they notice or why something happens. For example, a conjecture made by a child could be 'I think that when you multiply an odd number by an even number, you are always going to end up with an even number'.
- **Convince** – children should then be encouraged to convince or to persuade people (their classmates, teachers or any adults at home) that their conjectures are true. In the process of convincing, children may use some, or all, of their other 'maths powers'.
- **Organise** – children should be encouraged to organise or put things, such as numbers, facts and shapes, into groups, an order or a pattern.
- **Classify** – children should then be encouraged to classify the objects they have organised, for example, by identifying the groups as odd or even numbers, or irregular and regular shapes.
- **Imagine** – children should be encouraged to imagine objects, patterns, numbers and resources to help them solve problems and reason about mathematics.
- **Express** – children should be encouraged to express their thinking, and to show and explain their thinking and reasoning about a problem, relationship or generalisations.
- **Specialise** – children should be encouraged to look at specific examples or a small set of examples of something to test their conjecture. For example, a child might use the numbers seven and eight to test their conjecture that an odd number multiplied by an even number equals an even number.
- **Generalise** – children should be encouraged to generalise and to make connections, then use these to identify rules, patterns and relationships. For example, they could generalise that any odd number multiplied by any even number equals an even number. Children should also be encouraged to use algebra to express their generalisations.

These mathematical superpowers have become the central foundation of many development programmes for maths teachers, including the Maths Specialist Teacher (MaST) programme.

Becoming maths superheroes

It's important that children's maths superpowers, and therefore their ability to problem solve, reason and apply mathematics, are developed as part of a teacher's day-to-day maths lesson, rather than just being the focus of one lesson a week, if that, which is sometimes the case.

One way in which this can be achieved is through the use of key questioning strategies, and I have provided a full list of these in the *Problem Solving and Reasoning* series of books, which I have authored for Rising Stars. However, below is an insight into three of these key strategies, which you can pick up, adapt and use in your day-to-day maths teaching:

Always, sometimes, never true

Give students a statement and then ask whether it is always, sometimes or never true.

This line of questioning encourages children to think about the concept of mathematical proof, and allows them to develop the key skill of proving or disproving a statement. This key strategy is very effective at encouraging children to make connections between different areas of mathematics and for encouraging generalisations and algebraic thinking.

For each example question below, some suggestions for further prompts and questions are provided.

1. Is it always, sometimes or never true that multiplication makes things bigger?
   a. Can you think of any multiplication you could do that would not make your starting number bigger?
   b. What happens if you multiply by a negative number?

2. Is it always, sometimes or never true that the number of diagonals in a shape is equal to the number of sides?
   a. Let's look at a pentagon – how many diagonals does a pentagon have?
   b. How about a square?

Hard and easy

Ask the children to give you an example of a 'hard' and 'easy' answer to a question, explaining why one is 'hard' and the other 'easy'.

This strategy encourages children to think closely about the structure of mathematics and enables them to demonstrate an understanding of concepts. Children enjoy the challenge of coming up with 'hard' examples that still meet the requirements set out in the question. The choices children make when responding to this strategy often provide valuable information about what they find difficult, which may not always be what you expect! For example, if a child

constantly gives calculations involving decimals as 'hard' questions, then this would probably indicate they are insecure with decimal place values.

For each example below, real responses from children, including their justifications are provided.

1. Give me a hard and easy example of a question that asks you to find a proportion of a number.
   - Easy – half of four, as halves and doubles of single-digit numbers should be known facts for everyone.
   - Hard – three-ninths of 187, as 187 is not a multiple of 9, therefore this would be more difficult to carry out mentally.

2. Give me a hard and easy example of a way to sort the children in our class.
   - Easy – by gender, as there are only two groups and it is obvious who belongs to which.
   - Hard – by height, as there are no defined groups and there is likely to be a large range of heights in our class.

Same difference

Give the children at least two statements, objects or numbers and ask them to compare them by asking: 'What's the same? What's different?'

This strategy encourages the children to compare and contrast. It fosters the children's ability to spot patterns and similarities, to make generalisations and to spot connections between different aspects of mathematics. The open-ended nature of the key strategy enables all children to contribute, regardless of their ability, and support can easily be added.

For each example below, real responses from children are provided along with suggestions of how the teacher could develop these responses further.

1. What's the same and what's different about a line graph and bar chart?
   - Same – both are types of graphs which show data.
   - Different – line graphs can be used to show continuous data, whereas bar graphs cannot.

The teacher could then explore the different types of data possible to display on different types of graphs.

2. What's the same and what's different about one-quarter and 25 per cent?
   - Same – both are a proportion and both represent the same proportion (one in four), therefore one-quarter of a number and 25 per cent of a number would be equal. Also, both are equal to 0.25.
   - Different – one is a fraction whereas the other is a percentage.

The teacher could then explore the equivalence between and ways to convert fractions, decimals and percentages.

Making it visual

In addition to developing problem solving and reasoning skills, in order to help children get a better understanding of maths, it's important to incorporate models, images and practical resources. We need to help students develop a true conceptual understanding of maths so they can take on the new curriculum with ease.

Resources such as bead strings, number lines, 100 squares, thinking strips, and the 'bar model' are ideal representations of mathematical concepts.

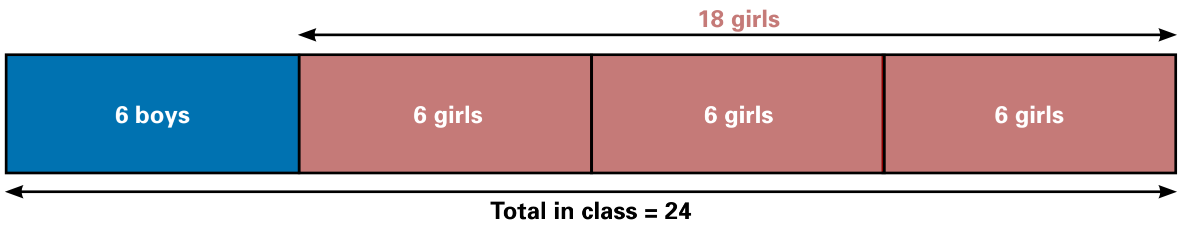
The bar model

The bar model is based on work by American psychologist, Jerome Bruner, and is now used extensively and successfully in schools in Singapore. It involves drawing a rectangular bar to represent a specific quantity. Once students have learned to solve simple mathematical problems using bar modelling, they can apply this to any number of mathematical problems.

But how does the bar model work? Let's try and solve the following word problem, taken from the 2012 Key Stage 2 SATs paper:

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

Pupils first draw a bar to represent the whole class. They then mark on the known information (one-quarter of the class are boys, so the rest, which must be three-quarters, have got to be girls. There are 18 girls in total). It is then clear that each quarter of the class has 6 children in it. The pupils would add this to their representation, and therefore be able to see the total in the class is 24:



Using the support available

Schools should make use of any support or training offered to them. Whether it's from publishers like Rising Stars, local authorities or Maths Specialist Teachers (MaST), schools need to take advantage of this assistance to ensure their staff are ready to teach the new curriculum.

Schools should also work together, especially with other schools in their cluster. I have just supported my school clusters in developing a common calculation policy, which runs from the Early Years Foundation Stage (EYFS) to Year 8.

The National Centre for Excellence of Teaching Mathematics (NCETM) is producing a range of various free online resources, and there are also a growing number of NCETM accredited professional development leads who have been trained by the NCETM to support schools taking on the new curriculum. A national network of maths hubs has also just been announced, and as they become established, will also be a very useful source of support, advice and guidance.

Implementing the new maths curriculum may seem like a very daunting prospect for many teachers, but it doesn't have to be. With careful thought, planning and a slightly different way of thinking, schools will be able to put themselves in a strong position to take on this challenge and increase both the standard of achievement and enjoyment of mathematics in the primary phase.

Knowledge trails

1. **Can you be creative in maths? –** There's more than one way to approach a maths problem and still come up with the right answer. Maybe it's time we let students figure it out for themselves, say Liz Pumfrey and Charlie Gilderdale. **library.teachingtimes.com/articles/can-you-be-creative-in-maths**

2. **Maths adventures –** An alternative to computer-based mathematical games has caused children to 'hug each other in excitement'. Alan Parr explains. **library.teachingtimes.com/articles/ctl-1-4_maths-adventure**

3. **Talking mathematically –** Rod Cunningham argues in favour of Philosophy for Children as a training ground for dialogue in mathematics and suggests resources for developing mathematical thinking. **library.teachingtimes.com/articles/talking-mathematically**