Report summary

Good practice in primary mathematics: evidence from 20 successful schools

Mathematics is all around us; it underpins much of our daily lives and our futures as individuals and collectively. As the Secretary of State for Education said last year:

> '... mathematical understanding is critical to our children's future. Our economic future depends on stimulating innovation, developing technological breakthroughs, making connections between scientific disciplines. And none of that is possible without ensuring more and more of our young people are mathematically literate and mathematically confident. Mathematical understanding underpins science and engineering, and it is the foundation of technological and economic progress. As information technology, computer science, modelling and simulation become integral to an ever-increasing group of industries, the importance of maths grows and grows.'

It is therefore of fundamental importance to ensure that children have the best possible grounding in mathematics during their primary years. Number, or arithmetic, is a key component of this. Public perceptions of arithmetic often relate to the ability to calculate quickly and accurately – to add, subtract, multiply and divide, both mentally and using traditional written methods. But arithmetic taught well gives children so much more than this. Understanding about number, its structures and relationships, underpins progression from counting in nursery rhymes to calculating with and reasoning about numbers of all sizes, to working with measures, and establishing the foundations for algebraic thinking. These grow into the skills so valued by the world of industry and higher education, and are the best starting points for equipping children for their future lives.

Criticism of learners' skills in number regularly hit the headlines, especially at the points of transition to the next phase of education or work – ages 11, 16, 18 and beyond. Even those who have achieved the nationally expected levels of performance, such as Level 4 at age 11 or GCSE grade C at age 16, are criticised for not being able to use mathematics effectively. Far fewer column inches are given to celebration of those who can, but that is not a recent phenomenon.

The National Numeracy Strategy, introduced in 1999, provided detailed guidance on the teaching of mathematics through daily lessons in Key Stages 1 and 2 and promoted whole-class interactive teaching. The Strategy's primary framework and supporting materials have been widely adopted by maintained primary schools. The aim with calculation was to teach a series of mental and informal methods to develop pupils' grasp of number and flexibility in approaches, before moving on to more efficient traditional ways of setting the calculations out.

The Coalition Government has initiated a review of the National Curriculum, taking into account the curricula of high performing countries in mathematics, many of which focus strongly on conceptual understanding of number. *The importance of teaching: the Schools White Paper,* 2010, emphasises the importance of good teaching in mathematics, especially in primary schools, and for pupils' essential grasp of the core mathematical processes and arithmetical functions.

This report examines the work of a sample of 10 maintained and 10 independent schools, all of which have strong track records of high achievement in mathematics. It focuses on identifying characteristics of effective practice in building pupils' secure knowledge, skills and understanding of number so that they demonstrate fluency in calculating, solving problems and reasoning about number. The report also looks at the choices of methods pupils make when presented with calculations and problems to solve. Some key common factors emerge, which might be more widely replicated, as well as some differences between the schools.

Key findings

The following key findings, taken together, reflect the 'what' and 'how' that underpin effective learning through which pupils become fluent in calculating, solving problems and reasoning about number.

- Practical, hands-on experiences of using, comparing and calculating with numbers and quantities and the development of mental methods are of crucial importance in establishing the best mathematical start in the Early Years Foundation Stage and Key Stage 1. The schools visited couple this with plenty of opportunities for developing mathematical language so that pupils learn to express their thinking using the correct vocabulary.
- Understanding of place value, fluency in mental methods, and good recall of number facts such as multiplication tables and number bonds are considered by the schools to be essential precursors for learning traditional vertical algorithms (methods) for addition, subtraction, multiplication and division.
- Subtraction is generally introduced alongside its inverse operation, addition, and division alongside its inverse, multiplication. Pupils' fluency and understanding of this concept of inverse operations are aided by practice in rewriting 'number sentences' like 3 + 5 = 8 as 8 – 3 = 5 and 8 – 5 = 3 and solving 'missing number' questions like □ – 4 = 5 by thinking 5 + 4 = 9 or 9 – 4 = 5.

- High-quality teaching secures pupils' understanding of structure and relationships in number, for instance place value and the effect of multiplying or dividing by 10, and progress in developing increasingly sophisticated mental and written methods.
- In lessons and in interviews with inspectors, pupils often chose the traditional algorithms over other methods. When encouraged, most showed flexibility in their thinking and approaches, enabling them to solve a variety of problems as well as calculate accurately.
- Pupils' confidence, fluency and versatility are nurtured through a strong emphasis on problem solving as an integral part of learning within each topic. Skills in calculation are strengthened through solving a wide range of problems, exploiting links with work on measures and data handling, and meaningful application to cross-curricular themes and work in other subjects.
- The schools are quick to recognise and intervene in a focused way when pupils encounter difficulties. This ensures misconceptions do not impede the next steps in learning.
- Many of the schools have reduced the use of 'expanded methods' and 'chunking' in moving towards efficient methods because they find that too many steps in methods confuse pupils, especially the less able. Several of the schools do not teach the traditional long division algorithm by the end of Year 6 (age 11) and most of those that do say that a large proportion of pupils do not become fluent in it.
- A feature of strong practice in the maintained schools is their clear, coherent calculation policies and guidance, which are tailored to the particular school's context. They ensure consistent approaches and use of visual images and models that secure progression in pupils' skills and knowledge lesson by lesson and year by year.
- These schools recognise the importance of good subject knowledge and subject-specific teaching skills and seek to enhance these aspects of subject expertise. Some of the schools benefit from senior or subject leaders who have high levels of mathematical expertise. Several schools adopt whole-school approaches to developing the subject expertise of teachers and teaching assistants. This supports effective planning, teaching and intervention. Most of the larger independent preparatory schools provide specialist mathematics teaching from Year 4 or 5 onwards.

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