Speech

Nick Gibb: building a renaissance in mathematics teaching

From: Department for Education and Nick Gibb MP
Delivered on: 12 July 2016 (Transcript of the speech, exactly as it was delivered)
Location: Advisory Committee on Mathematics Education (ACME) conference, The Royal Society, London
First published: 26 July 2016
Part of: School and college qualifications and curriculum

Schools minister addresses delegates at the Advisory Committee on Mathematics Education (ACME) conference.

Can I start by thanking you for inviting me to join you at your conference today. I hugely appreciate the work that ACME have done to inform both government policy and classroom practice since its foundation in 2002.

Since I first became Shadow Schools Minister in 2005, I have visited several hundred schools. During my visits, particularly to primary schools, I often ask whether I can speak to the class as a whole. Over the years, I have developed something of a lesson

routine: I explain to pupils the job of a government minister; a little bit about how Parliament works; and a few titbits of British history. And I also quiz pupils on their general knowledge, in particular on their times tables. And I think it is becoming general knowledge that I do this, and it deters schools from inviting me.

And over the years I have noticed a change. When I ask pupils, "Do you know your times tables?" I am increasingly greeted, not with downward looks and shuffling feet, but with confident classroom cheers of "Yes!" Last month, I was in Chacewater Community Primary School in Cornwall, and every year 3 and 4 pupil I quizzed had automatic recall of all their times tables, even the tricky 7 times table, and all the way up to 12 times 12.

Now, some of you may be thinking, "The Schools minister is talking about times tables again. When will he realise that mathematics is about so much more about this?" I willingly accept that immediate recall of basic number facts is not the totality of mathematics education. Conceptual thinking and real world problem-solving are - ultimately - what we need our pupils to be able to perform once they leave school.

But, as recent and rigorous research into cognitive psychology has shown, number knowledge and fluency in written calculation are not the antithesis of problem solving in mathematics. Rather, they are the royal road by which complex mathematical thinking is achieved.

And that is why I am so delighted to see increased evidence on the ground of schools ensuring their pupils master these basics, before more complicated mathematics is introduced.

Today, I want to celebrate a renaissance in mathematics teaching that is taking place in our schools. Currently happening on a small scale, it has the potential to revolutionise the teaching of the subject in this country.

Before I was elected to Parliament, I worked as a chartered accountant. As such, I belonged to a select group of people for whom it is not socially acceptable to claim "I can't do maths." For decades, this phrase - "Can't do maths" - has been a common

refrain in British culture. It is extraordinary that in a country which produced Charles Babbage and Bletchley Park, a deficiency at mathematics has come to be seen as a defining national characteristic.

But there are high-performing jurisdictions abroad, as well as exceptional schools at home, which demonstrate that the vast majority of children, if taught well, can achieve at mathematics. See for example King Solomon Academy, a non-selective school in central London.

This school places a strong focus on depth before breadth in numeracy and literacy, and in 2014, all but 5% of King Solomon Academy pupils achieved a GCSE in mathematics at grade C or above, and in fact 82% achieved at grade B or above. This is an astonishing achievement for any non-selective school, let alone an inner-city school with a proportion of disadvantaged pupils over 3 times the national average.

And King Solomon Academy is not alone: Bethnal Green Academy in east London, Thomas Telford School in the West Midlands, Emmanuel College in Gateshead, are all comprehensive schools, serving socially mixed populations, where well over 90% of pupils get a good GCSE in mathematics.

Of course, the expert mathematics teaching we see in the best of our schools does not yet characterise all of our schools. According to the international PISA tests carried out by the OECD, 22% of 15-year-olds in this country performed at the lowest level of mathematics proficiency in 2012. This means they were unable to carry out simple tasks such as recognising that travelling 4 kilometers in 10 minutes means going at the same speed as travelling 2 kilometers in 5 minutes.

In countries such as Korea and Singapore, and cities such as Hong Kong and Shanghai, the percentage of low-performing 15-year-olds is below 10%. There is nothing different about children in these countries, but there is something different about their approach to teaching maths.

To learn more about maths teaching in these countries, the

government founded the maths hubs programme in 2013. Thirty-five maths hubs have been established in schools or groups of schools throughout England, to become centres of expertise in south-east Asian mastery teaching.

Over the past 2 years, we have arranged for 127 teachers from Shanghai to teach in English schools for 3 weeks, and 131 teachers from England to teach in Shanghai. This partnership will continue over the next 2 years, with many more teachers from England and China benefiting from the exchange programme and the opportunity this offers to strengthen the teaching of maths in primary schools.

According to an independent evaluation by academics from Sheffield Hallam University, based on data collected between February and July last year, early indications are that the exchange has the potential to foster a radical shift in mathematics teaching in participating primary schools.

One primary school profiled in the report had implemented many aspects of Shanghai teaching, such as: additional lessons for pupils needing more support; 35 minute lessons, with the first focused on developing conceptual understanding, and the second on practice and consolidation of new content; and a change of classroom organisation from small groups of tables based on attainment, to rows of children facing the front - leading to more whole-class engagement. The school reports that pupil results have already seen an increase in that school.

The report also stated that across all 48 schools in the hub network, most teachers reported that the changes implemented had led to positive outcomes for pupils, which included an “increased enthusiasm for mathematics, deeper engagement, increased confidence, and higher levels of attainment”. The report cited examples of schools’ improved outcomes, including, and I quote, “in one school, year 3 pupils who followed a mastery approach achieved higher scores than year 4 pupils who had been taught in the usual manner on the same assessment task”.

I had the great privilege of travelling to Shanghai in March to witness their maths teaching. Of course, there was an admirable

emphasis on mastering the basics. But I was also greatly impressed by the emphasis placed on ensuring mathematical procedures and knowledge are underpinned by strong conceptual understanding, often through visual representations. In addition, a great emphasis was placed in these schools on ensuring that pupils use clear and precise mathematical language from an early age to articulate the procedures they perform.

But perhaps most crucially, the knowledge, examples and questions which underlie successful teaching across south-east Asia are embodied in detailed curriculum, and high-quality textbooks.

I have frequently spoken about my belief that pupil outcomes in Britain have been held back, significantly held back, by an anti-textbook ethos in our schools. This ethos is based on a longstanding prejudice that equates textbooks with unimaginative teaching. It is clearly reflected in international surveys of teaching practice. According to the 2011 TIMSS international survey, 70% of Singaporean pupils in year 5 are taught by teachers who use textbooks as a basis for instruction in lessons. In Finland, the figure was 95%. But in England, the figure was 10%.

A similar finding exists in the OECD's Equations and Inequalities report published last month. Of all 64 participating countries, the UK had the third lowest proportion of pupils taught in schools with a formal mathematics textbook policy. According to the survey, only 2% of UK pupils attend schools where either heads, local authorities, or national government choose textbooks. This was the fourth lowest proportion in the OECD. Together, these figures suggest that schools in the UK, almost uniquely, have not seen textbook choice as an area for strategic school improvement.

By contrast, in Shanghai and Singapore, an enormous amount of thought and care goes into the construction of maths textbooks, planning in great detail the sequence of teacher exposition. No pupil's understanding is left to chance or accident: every step of a lesson is deliberate, purposeful and precise.

Contrary to what many critics suppose, the common curriculum and textbooks in south-east Asia do not constrain teacher creativity. Quite the opposite: high-quality resources provide a foundation upon which creative and imaginative teaching can be built.

In the spirit of learning from the best jurisdictions in the world for teaching mathematics, I am delighted that England's maths hubs are currently trialling 2 English adaptations of Singapore mathematics textbooks, entitled 'Maths No Problem' and 'Inspire Maths'. The feedback we are getting from teachers and pupils so far is overwhelmingly positive, not least due to the workload savings that a well-designed textbook can provide.

In addition, maths hubs are learning that south-east Asian teaching methods depend upon whole-class instruction from the teacher. As Charlie Stripp from the National Centre for the Excellence in the Teaching of Mathematics has observed, this does not mean reducing pupils to being passive recipients of boring lectures, as some caricatures of south-east Asian teaching suggest. Teaching there is teacher-led, but not teacher-dominated, with constant questioning and interaction between the teacher and the pupils in the class.

In 2014, a fascinating piece of research was published by Professor David Reynolds of Southampton University, and his Chinese postgraduate research student Zhenzhen Miao. They videoed lessons in both countries, to find out what teaching methods were being used to such great success in the Chinese classroom. The answer was clear: in Chinese classrooms, whole-class interactive teaching made up 72% of lesson time, compared with only 24% of lesson time in England. In England, almost half of the time - 47% - was used up on pupils working individually or in groups, compared with only 28% of the time in China.

But perhaps most importantly of all, mastery mathematics teaching is based upon the principle that, if taught well, all pupils can master the content of a lesson. According to the OECD's Teaching and Learning International Survey,

differentiated teaching is not common in high-performing south-east Asian countries. This is because it reinforces the performance gap between high and low attaining pupils. Across the OECD as a whole, the practice of differentiating work by ability whilst teaching has a negative relationship with pupil outcomes - an insight provided by the maths teacher and education blogger Greg Ashman.

Through visiting maths hubs and talking to their teachers, I have been consistently impressed by how positively teachers have engaged in the project. Over the next 4 years, we will spend up to £41 million cascading south-east Asian mastery teaching to primary schools throughout the country via our maths hubs network. This money will subsidise new mastery textbooks in thousands of primary schools, train a cadre of 700 specialist mastery teachers, and fund teacher release so that more teachers can - in turn - be trained by them.

Supporting maths hubs in delivering this ambitious vision will be the National Maths Education Centre, which I am launching the tender for today. The centre will provide leadership to our maths hubs in transforming primary mathematics, through training teachers in south-east Asian mastery methods.

Such measures will ensure that, in time, mastery methods are the default approach for teaching mathematics in primary schools throughout the country.

Today also marks the publication of Stephen Munday's report into core content for initial teacher training, and David Weston's new standard for professional development. Both Stephen and David have worked hard, canvassing a broad and varied set of opinions, yet still managing to find some clear and well expressed principles to guide both the initial and the continuous training of classroom teachers.

I am particularly pleased that both Stephen and David's reports emphasise the importance of subject knowledge, and pedagogical subject knowledge. Much of teaching is, of course, a craft. But it is a craft that is underpinned with concrete knowledge about what to teach, and how best to teach it. Both

reports emphasise that high-quality professional development does not end with becoming a qualified teacher, but should continue throughout a teacher's career.

Nowhere is this more the case than in mathematics. A good maths teacher will know precisely how best to explain ratio, prime numbers, and expanding brackets in an algebraic equation, and will be able to anticipate the common misconceptions that can occur. These reports, along with the expanded funding of the maths hubs project, should ensure that high-quality subject-based training will be available for teachers for years to come.

This government has also pledged to introduce a computerised multiplication check to ensure that basic number facts are being mastered by pupils before they leave primary school. The announcement was received positively by many parents and teachers. But I am disappointed that some influential voices within maths education remain opposed.

One English educationist, now residing at an American university, appeared in the TES in December arguing she would "ban" times table tests, and told the Telegraph that they have nothing to do with mathematics. Earlier last year, Conrad Wolfram wrote in the Financial Times that calculation is an "obsolete skill", thanks to technological advances of the 21st century.

That last comment reminded me of an influential pamphlet about the future of mathematics entitled 'I do, and I understand'. This pamphlet suggests that in the age of the computer and the "simple calculating machine", mental arithmetic has become a thing of the past. It was written in 1967. Such a romantic view was wrong then, and I believe it is wrong today.

Five decades of research into cognitive science, as reviewed by the American psychologists James Royer and Loel Tronsky, shows that there is a positive relationship between computational automaticity and complex mathematical problem-solving skills.

Of course, mathematics is not limited to number knowledge, just

as reading is not limited to decoding words. But fluent number knowledge is an unavoidable gateway to pass through before achieving the more valuable prize of complex problem-solving. When your working memory is freed of having to make simple calculations, it can think more fully about the conceptual underpinnings of a problem. As the American cognitive scientist Daniel Willingham has written, “This automatic retrieval of basic math facts is critical to solving complex problems, because complex problems have simpler problems embedded in them.”

A lovely example of this was provided by the mathematician Hung-Hsi Wu, in the magazine American Educator. In order to illustrate to pupils the concept of a repeating decimal sequence, teachers may want to ask pupils to carry out a long division sum such as 1 divided by 3. But in order to carry out that long division, pupils will need to have automatic recall of some simple addition and subtraction sums. Thus, a fluency in number facts, and a knowledge of the long division procedure, are necessary for pupils to understand the concept of a repeating decimal.

Whilst I believe that significant mistakes have been made in the fashions of mathematics teaching in the past, there are many reasons also to be optimistic about the subject’s future. Pupils themselves are increasingly recognising the benefits of studying mathematics past GCSE. Since 2010, the proportion of pupils entering mathematics A level has increased by 18%, the proportion entering further maths A level has increased by 27%, and the proportion entering physics A level has increased by 15%.

In addition, we have encouraged many more pupils to continue studying maths beyond the age of 16 through developing the new core maths qualification. Pupils who achieve a good GCSE in maths are now able to keep the subject fresh in their minds through studying the application of mathematics in real life situations. In the data-rich world in which we live, many, many more academic subjects require a basic facility with numbers and statistical analysis, and the core maths qualification will help pupils achieve this.

However, we need to go even further. This is why the

government has commissioned Professor Sir Adrian Smith to review the case and feasibility for more or all students continuing to study maths to 18 in the longer-term. His review, the terms of reference of which we have published today is looking at how we can build on recent rises in participation and the introduction of vital new qualifications to ensure that as many pupils as possible learn the skills they will need to succeed in the modern economy.

Not enough pupils currently leave education with these skills, but where pupil outcomes at mathematics in this country are low, I do not believe it is because of a lack of good teachers, or good schools, or good parents. I believe it is because of a lack of good ideas.

The current renaissance in mathematics teaching is enlivening our classrooms with good ideas about mathematics teaching from around the world. Through the government's maths hubs programme, the evidence of cognitive scientists, and the innovation brought about by increased school autonomy, teaching methods in mathematics are improving year on year.

Methods that were once castigated as 'outdated' and 'bad practice', such as memorisation, frequent assessment, and the use of textbooks, are being rehabilitated in English classrooms. For someone who visits schools across the country every week, this change is palpable.

With such developments continuing, I am confident that we will one day have a country where mass innumeracy, and the phrase "Can't do maths," are things of the past. The demands of the working world in the 21st century are such that all pupils - and not just the future accountants of this world - must have it within them to "Do maths."

Published:

26 July 2016

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Department for Education

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Part of:

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