Speech

Getting the basics right in mathematics

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Schools Minister Nick Gibb speaks at Elmhurst Primary School about the importance of learning multiplication tables and number facts.

It is a delight to be back here at Elmhurst Primary School. During my time as Schools Minister, I have learnt a great deal from both Elmhurst Primary School and your inspiring head Shahed Ahmed, and I have enormous admiration for the academic outcomes that your pupils achieve.

I'm sure he won't mind me saying, Shahed and I share a belief in the importance of getting the basics right in primary education, be it phonics, arithmetic or handwriting. But that is not the only thing we share. My sources tell me that in a previous life Shahed, like me, worked as a chartered accountant - though I believe that I lasted a little longer in the profession than Shahed.

Now, as accountants, we belong to a small minority of people in England for whom it is not socially acceptable to say ‘I can’t do maths’. Sadly, for many others in this country, such a claim is commonplace. 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 feature.

The idea that maths is something some people can do, and some people cannot, is cognitively untrue for all but a tiny minority of people. It is also of dire consequence for adult’s livelihoods, and our country’s economy.

According to the international PISA tests carried out every three years by the OECD, 22% of fifteen year olds in this country are functionally innumerate. This means they are unable to carry out simple tasks such as recognising that travelling 4km in 10 minutes means going at the same speed as travelling 2km in 5. Such a record places us well behind countries such as Korea and Singapore, and cities like Hong Kong and Shanghai in China, where the percentage of innumerate 15-year-olds is below 10% in each.

The PISA survey which produced those results was carried out in 2012. Since then, the situation may, perhaps, have been changing for the better. 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.

Elmhurst Primary School’s fantastic results, where 60% of pupils last year achieved a level 5 or above in their key stage 2 mathematics - is an example of the excellent standards English schools can achieve. Due to its strong track record on mathematics, Elmhurst was made one of England’s 35 maths hubs in 2014. The maths hubs have been funded by the Department for Education to disseminate expert mathematics teaching throughout this country’s schools.

In particular, teachers at maths hubs are finding out what we can learn from international leaders, such as Singapore and Shanghai. Over the past 2 years, the maths hubs have arranged

for 127 teachers from Shanghai to teach in English schools for 3 weeks, and 131 teachers from England to teach in Shanghai.

Through visiting maths hubs and talking to their teachers, I have been consistently impressed by how positively teachers are engaging in this project. The Maths Hub programme will continue into 2016 to 2017 and hub budgets will be confirmed in March 2016.

One of the most inspiring teachers I have met since becoming Schools Minster is Bruno Reddy. As head of mathematics, he helped found King Solomon's Academy in 2009. As a maths specialism school, it developed a mathematics curriculum which focuses on depth of understanding before breadth of study. In the school's most recent results, 82% of its pupils gained a GCSE in mathematics at B or above, and 95% at C or above - an astonishing achievement for any school, let alone an inner-city school with a proportion of disadvantaged pupils around 3 times the national average.

At A level, pupils appear to be gaining, not losing, an enthusiasm for mathematics. Due in part to this government's emphasis on the importance of STEM subjects, there has been, since 2010, a 15% increase in pupil entries for physics, an 18% increase in pupil entries for maths, and a 27% increase in pupil entries for further maths.

2014 saw the opening of the Kings College London Maths School in Lambeth, a small free school for sixth formers where all of the pupils study mathematics, further mathematics and physics. This summer, the school reported that 72% of pupils attained AAB or better, and 97% of pupils attained an A-grade in mathematics. Such exemplar schools show what can be achieved by pupils in this country. The challenge now is making sure that the approach to mathematics that characterises the best of our schools, can spread to the rest of our schools.

I do not believe that outcomes in mathematics are low for many pupils in this country because of bad teachers, or bad schools, or bad parents. Where pupil outcomes are low, I believe it is because of bad ideas.

What ideas am I talking about? I am talking about the idea that sustained practice is too boring to engage pupils. I am talking about the idea that teacher led instruction and worked examples in mathematics are passive. I am talking about the idea that memorising your multiplication tables is antiquated in the age of the smart phone. For half a century, these ideas have been propagated by a romantic belief that the discipline can be taken out of mathematics, and the learning can remain. But as our best schools know, this is not possible. Memory, testing and teacher instruction are all vital components for success in the subject.

Take the last example - multiplication tables. This government has pledged to introduce a computerised multiplication check for all year 6 pupils at the end of primary school. The announcement was received positively by many parents and teachers. But some influential voices within 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 Wolfman 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’, which suggests that in the age of the computer and the ‘simple calculating machine’, mental arithmetic has become a thing of the past. That pamphlet was written in 1967. Its romantic view was wrong then, and it is wrong today.

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

For example, a 2001 study gave 200 American pupils aged 7 to 11 a battery of tests assessing basic skills, followed by a mathematics test involving complex problem solving. Speed at basic arithmetic in 4th grade still had a small but statistically

significant relationship with complex problem solving ability 1 year later, when controlling for a child's verbal IQ, processing speech, and reading ability.

In 2013, a controlled trial was carried out where 195 first grade pupils in America who were struggling with mathematics were given 16 weeks of specific tutoring where they practiced simple sums. The pupils were then tested on areas such as word problems, arithmetic and 2-digit calculations. Compared to the control group who received no such tutoring, these pupils had a statistically signification improvement in all 4 areas tested. Revealingly, those children who practised simple sums in timed conditions using flashcards, improved even further, showing that repeated practice aids memory.

And there is absolutely no reason why such practice has to be dull and dispiriting. Just look at the 'Rolling Numbers' chants developed at inner-city American charter schools to learn multiplication tables, or the wildly successful Times Tables Rock Stars programme developed by Bruno Reddy. You will see children delighted with the sense of achievement which comes from mastering mathematical knowledge.

Of course, mathematics is not limited to number knowledge, just as reading is not limited to decoding words. Memorising sums and times tables is simply an important gateway for achieving the far more valuable prize of conceptual understanding in mathematics. 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. Being able to carry out long division can open the door of understanding as to why some fractions, such as one third, are repeating decimals. You keep on dividing, and you keep on getting 3!

A large body of evidence from cognitive scientists demonstrates that knowledge and understanding in mathematics proceed in tandem, and should be taught together. This insight is well understood by mathematics teachers in the Far East.

I have been most impressed by the focus teachers from Singapore and Shanghai place, not just on basic skills, but also on developing clear conceptual understanding. From the maths hubs, I have learnt about the importance of using real life illustrations of mathematical problems to give pupils a clear understanding of the concepts that underlie procedures. Lessons move from concrete examples, to pictorial examples, to abstract procedures. From sharing biscuits, to dividing up a shape, to simple division - as an example.

And a huge amount of thought goes into finding examples which will resonate with pupils. One teacher joked with me that whilst household pets may be an excellent analogy for gathering like terms, it is much better to discuss splitting a journey along a road into thirds, than a kitten.

Crucially, the knowledge, examples and questions which underlie successful teaching in the Far East are embodied in a detailed curriculum, and high quality resources. An enormous amount of thought and care goes into the construction of mathematics textbooks in Shanghai and Singapore, planning in great detail every step of the algorithm or calculation. No pupil's understanding is left to chance or accident: every step of a lesson is deliberate, purposeful and precise.

It is revealing that, 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 England, that figure was 10%.

This is not to say that the common curriculum and textbooks in the Far East constrain teacher creativity. Quite the opposite: high quality resources provide a foundation upon which creative and imaginative teaching can be built. 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’.

In addition, Shanghai 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, as some caricatures of Chinese teaching suggest. Shanghai teaching is teacher-led, but not teacher-dominated, with constant questioning and interaction between the teacher and 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, interactive whole-class 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, Shanghai mathematics teaching is based upon the principle that, if taught well, all pupils can master the content of a lesson. Differentiated teaching is not common in Shanghai, as it reinforces the performance gap between pupils. Across the OECD as a whole, the use of differentiating by ability whilst teaching has a negative relationship with pupil outcomes - an insight provided by the maths teacher and education blogger Greg Ashman.

There appears to be no conception in Shanghai that some pupils can ‘do’ mathematics, whilst others cannot. Instead, the focus is on all pupils mastering a concept before moving to the next part of the curriculum sequence, allowing no pupil to be left behind.

The benefits of a good understanding of mathematics for pupils’ life outcomes are unarguable. The phrase ‘I am not good at maths’ should be banished from English schools, as it implies current difficulties are fixed within a child, suggesting that there

is no hope of these difficulties being overcome.

The way that we are going to improve maths in this country is simple: improved curriculum, quality resources, and better teaching methods.

I am delighted to be here today to open the new building at a maths hub which is leading the way in these developments. Through Shahed's travels to Shanghai, and Elmhurst Primary School's involvement as a maths hub, this school is an inspiring example of how we can learn from international best practice.

I hope that where Elmhurst Primary School leads, the rest of this country will follow. If so, we may one day have a country where mass innumeracy is a thing of the past, and all pupils - not just the future accountants - know they have it within them to 'do maths'.

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