Mathematical mindsets

Barbara Langford, director of studies and head of maths at Westbourne House, explores the challenges in changing the perceptions of mathematics

Whenever I speak to friends from the rest of Europe they are amazed that the English are prepared to admit that they "can't do maths". It seems that it is culturally acceptable to admit that one is innumerate when no one would admit that they were functionally illiterate. But what is maths? When many people think of maths they think of numbers, times tables and basic sums. Numeracy is, of course, important but having a sense of number and the ability to solve problems is of far greater value post school. After all, most people carry a phone with a calculator on it for basic numeracy, but problem solving skills and the ability to think logically and spot patterns are the skills that employers value so highly in pupils with good maths qualifications.

As maths teachers we are, therefore, struggling to challenge two common misconceptions (held often by parents if not, necessarily, by their offspring). Firstly, mathematics is uninteresting and just about being numerate. Secondly, that some people just do not have a maths brain. To clear these two hurdles we have to convince our pupils that maths is intriguing and fun for everyone and delivers far more than simple numeracy.

How do we change these beliefs?

The first step must be to make pupils (and their parents) aware that the human brain is malleable and that science has shown that we can all learn throughout our lives and get better at any subject. Too often, I am told by a parent that their child is poor at maths because they were. While it used to be believed that the brain one was born with could not really change, this canard has been disproved scientifically by many neuroscientists. How clever your parents are at maths and how good you are now, are not good indicators of what you can achieve in the future. (Carol Dweck)

No one is born "good at maths"; in the same way that no one is born speaking or walking. When we think that only some children have a "gift" or are talented at maths we are doing all our pupils a disservice. There is now much evidence that although people are born with different brains, these differences are totally over shadowed by the experiences people have (Wexler in Thompson, 2014). When we learn a new idea an electric current fires in our brain. The more we revisit this idea the more permanent the connections become.

Some people improve at maths faster than others but, as we all know from teaching, these early stars often peter out while other pupils catch up or even overtake. Some of it is just

hard work. My grandmother used to say that every genius was 1% inspiration and 99% perspiration. This perspiration or hard work is not just hours spent in a classroom but time spent specifically practising to get better, targeting weaknesses, and learning from mistakes.

There are many famous examples of people who "failed" but who went on to become world famous in the very sphere of life in which they had originally "failed". The Beatles were rejected by Decca Recording studios; Elvis Presley was kicked out of his school choir; Walt Disney was fired from a newspaper for having no ideas or imagination; Einstein couldn't talk until he was four.

In an experiment at University College London, neuroscientists looked at how London black cab drivers could remember the 25,000 streets within the 10 km radius of Charing Cross train station. The study found that the area of the brain associated with memory, the hippocampus, is enlarged in those working cab drivers. Crucially, they were not born with this enhanced capability but the hippocampus developed while they were learning "The Knowledge". A few years after retirement their hippocampus had begun to revert to normal again. (Maguire et al., 2006; Woollett & Maguire, 2011)

The second step is to celebrate mistakes that pupils make and view classwork as an opportunity to get things wrong and learn from these errors, rather than see the classroom as a place where everything has to be correct. I tell my students that if they get 100% then they haven't been challenged. If they knew everything to begin with, then there would be little point in being at school.

Setting is a thorny issue. If we accept that we all have the capacity to learn and do not want to label pupils, why do we set? Surely this just perpetuates the "gifted" mathematician myth. Well, maybe, and that is a discussion that will

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continue to run. At the moment, I'm happy that at Westbourne House School the bottom set is a small one. Here pupils are nurtured and able to make learning mistakes without fear of other pupil's ridicule.

Our third step is to re-educate the population about mathematicians. We should not be perceived as individuals working on obscure calculations in isolation, but team players - making connections and spotting patterns in the world around us in order to predict things like global warming and space exploration. Getting pupils to see the mathematical concepts that surround them and encouraging them to work collaboratively will help their perception of mathematicians as relevant and innovative.

Finally, as teachers we have to start thinking big. For example, how many balloons would it take to lift a house as in *Up*, the film? Or how many millions or billions of square cm of paper are their in a lavatory roll? Or building huge polyhedra (see photo below). These more open ended tasks, require the problem solving skills and teamwork that mathematicians use and not just the numeracy that pupils often see as maths.

Maybe this will not specifically help pupils to pass their Common Entrance, where single solution questions and answers are required under timed conditions, but it might make better mathematicians of our boys and girls and enable them to cope with the maths they encounter in every day life. It may even encourage more of them to continue their studies to University level and beyond.