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Mastery and Perceptions of Mathematicians in the Primary Curriculum

John Ryan, Senior Lecturer in Early Years and Primary Education at Birmingham City University

Primary mathematics remains a core subject in the National Curriculum (NC 2014), due to its prominence in everyday life, society and other curriculum areas (Haylock, 2014, Boaler, 2015). Not only does it provide pupils with skills, knowledge and understanding that helps them function on a day-to-day basis, it also enables pupils to develop intellectual curiosity, creativity and hone problem solving and reasoning skills, which are essential for preparing pupils for the future (Boaler, 2015). The mathematics content in the NC (2014) steadily progresses throughout the primary phase to ensure all pupils are taught and challenged flexibly and suitably (Haylock, 2014). However, a thorough and concise curriculum has little relevance without excellent teaching

which is mandatory for pupils to mathematically develop confidently, positively and successfully.

Standards relating to mathematics attainment amongst pupils has been a growing concern for successive governments in England. As a consequence, government policy has attempted to solve the problem by taking steps to increase attainment by seeking solutions and strategies from different approaches in other countries. When considering primary mathematics the most significant influence recently is teaching maths for mastery.

The government holds high aspirations for primary mathematics in England, and wants to ensure pupils are equipped with the knowledge and skills they need to succeed.

Mastery

Teaching for mastery in mathematics is fundamental to the government's education reforms. The National Centre for Excellence in Teaching Mathematics (NCETM) see https://www.ncetm.org.uk DfE and Ofsted have all endorsed this evidence-based approach which is inspired by some of the leading performers in mathematics education (including Shanghai and Singapore). The government holds high aspirations for primary mathematics in England, and wants to ensure pupils are equipped with the knowledge and skills they need to succeed. South East Asian countries rank highly in international mathematics tests (PISA, 2015), so over the past few years Maths Hubs (whose core purpose is to assist schools lead improvement in mathematics education) have been working closely with partner schools from these high performing jurisdictions. This has had a significant impact on primary mathematics pedagogy in English primary schools.

A mastery approach endorses that pupil's work at broadly the same pace, focusing on increasing depth rather than progressing beyond the expectations of their year group. Rapid intervention should be in place for pupils that need to consolidate their understanding before progressing and it is claimed that for this approach to be effective there needs to be a coherent, logical and consistent approach (NCETM, 2019). Pupils also need to have a secure understanding of number sense. Number sense is having an intuitive understanding of numbers, their value, relationships and how numbers are affected by operations. In tandem to this the importance of using and applying such knowledge and number sense should be considered and constantly referred to. According to NCETM a definition of mastery is that pupils have sufficient depth of understanding for learning to be sustained over time and built upon and connected to new learning. The interconnected five big ideas underpinning this are:

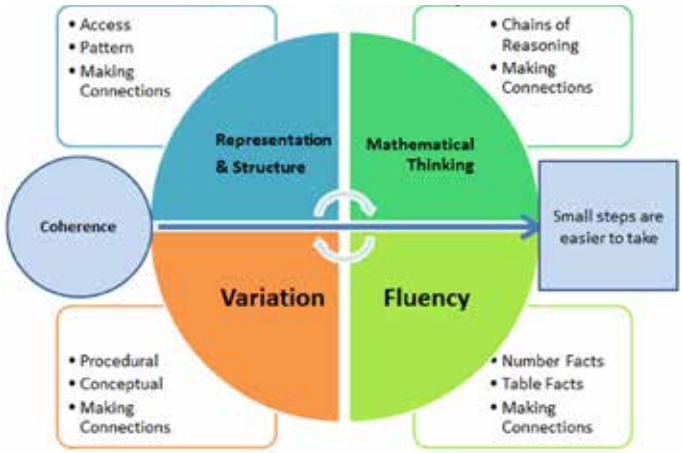
- Coherence and small steps;
- Representation and structure;
- Mathematical thinking;
- Variation;
- Fluency

How this is implemented in primary schools varies. Some schools have fully embraced mastery and have a consistent approach throughout the school, others are focusing on certain age groups, whist some schools are not adopting it fully and are only using certain elements of a mastery approach (NCETM, 2019). The mastery approach is not a new phenomenon though and the notion of mastery in primary mathematics was initially proposed in the 1910s and demonstrates an impressive impact on both pupil attainment and their attitudes to learning (McCourt, 2019). The mastery model for schools was implemented in much of the USA in the 1920s and 1930s.

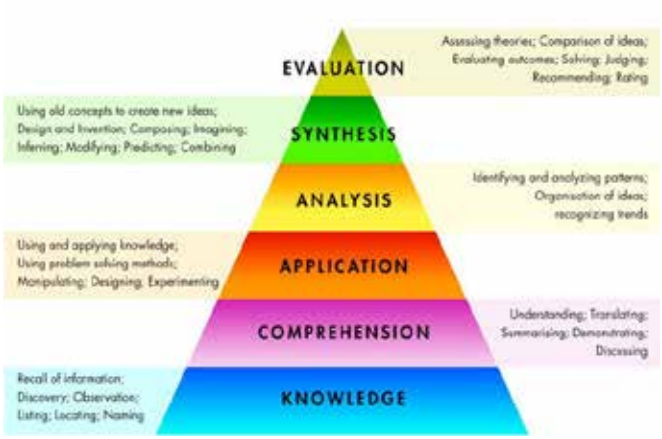
The concept of 'Learning for Mastery' was developed by Bloom (1968), who shortened the name to simply 'Mastery Learning' (Bloom, 1971). The famous triangle diagram which outlines the hierarchy of questions that need to be asked to achieve analysis, synthesis and evaluation, does not originate from Bloom and is an over simplification of his theories. Skemp (1976) also outlined instrumental and relational understanding of mathematics.

One of findings was that many pupils could not articulate what a mathematician might actually do.

Teaching for Mastery



Blooms Taxonomy



Instrumental is an understanding and described as rules without reasons. Whereas, Relational understanding is knowing both what to do and why, seeing relationships and making links. This chimes with the mastery approach concerning a deepened understanding of mathematics. A model of mathematical proficiency was developed by Kilpatrick and others (Kilpatrick et al 2001) which again has similarities with the mastery approach and most notably the five big ideas – these are:

- Productive disposition;
- Adoptive reasoning;
- Procedural fluency;
- Strategic competence;
- Conceptual understanding.

It is important that as educationalists we are aware that mastery is not a new approach to the pedagogy of mathematics.

A recent addition to statutory assessment in primary mathematics will be The Multiplication Table Check. This will involve Year 4 pupils being tested on multiplication facts for rapid recall, aligning with the principles of mastery (the most dominant being fluency and mathematical thinking). The new Y4 tests will not be universally popular, but staff in all schools should find time to debate the benefits or otherwise of these tests. The rationale behind the Year 4 timed tests for multiplication has been reported to aid schools and use such results as a diagnostic tool and it will be interesting to observe how this develops.

Perceptions of Mathematicians

To be successful in mathematics, have a deeper appreciation of how to apply mathematics and be viewed as a mathematician a relational understanding of mathematics rather than an instrumentational is essential. When investigating pupil's images of mathematicians Picker and Berry's (2000) findings revealed that a quarter of the drawings depicted a teacher. The main seven themes that were evident in research findings related to mathematicians were:

- Mathematicians as coercion
- The foolish mathematician
- The overwrought mathematician
- The mathematician who cannot teach
- Disparagement of mathematicians
- The Einstein effect
- The mathematician with special powers

One of findings was that many pupils could not articulate what a mathematician might actually do. This is rather concerning when considering professions that currently require a high level of mathematical subject knowledge. These professions include computer programmer, computer games designer, digital artist/animator etc… Another interesting finding was that younger pupils tended to have a more positive image of mathematics than older pupils.

Having worked alongside student teachers for over twenty years I often ask them to reflect on their own experience of learning mathematics. A concern expressed by student teachers relates to having the confidence and subject knowledge to teach primary mathematics. Many of the student teachers I work alongside agree that 'our view of the nature of mathematics affects the way we learn mathematics, the way we teach it, and will affect the way the pupils are taught mathematics' (Koshy, et al, 2000:4). Our experiences of mathematics can be compared to cabbage - you love it or hate it, depending on how it was served up to you at school. Teacher's attitudes and beliefs will impact on how they teach mathematics, so it is important to develop teacher's awareness of what these are and how they impact upon their own teaching. The importance of primary teachers in fostering a positive image of mathematics is therefore vital in attempts to dispel such negative stereotypes.

Conclusion

When discussing mathematics subject knowledge it is socially acceptable to share distain or disinterest. The way in which mathematics is presented to pupils will have an impact both positively and negatively on learners as well as inform their view of the subject. As educators we need to offer positive role models of mathematicians to pupils and share the career aspirations and opportunities that are available for pupils as they progress through their education. Fundamental foundations of mathematics are vital and the definition of number sense needs to be addressed. Indeed number sense is the underpinning for all advanced mathematics. We need to remember that number sense is 'knowing how a number can be composed and decomposed and using that information to be flexible and efficient with solving problems' (Parish 2014, 159). After all we want our current pupils in schools to feel confident and secure when they discuss their own experiences of primary mathematics as adults.

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Pen Portrait

John Ryan is Senior Lecturer in Early Years and Primary Education at Birmingham City University and teaches primary mathematics. He has worked in four other universities, University of Northampton, Birmingham, Nottingham and Newman University. He has also worked in many primary schools and was a leading Mathematics teacher for a Local Authority.
John is a member of ASPE's National Executive.

The next Bulletin in this series will be published on 1 January 2019

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Malini Mistry
Senior Lecturer in Early Years Education, University of Bedfordshire

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