MA2M+105

A teacher guide to mastery approaches and 'mathematical mindsets'

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NOTE: This guide is designed to be used in conjunction with a copy of Jo Boaler's 'Mathematical Mindsets' book:

Boaler, J. (2016) ***Mathematical Mindsets: Unleashing students' potential through creative math, inspiring messages and innovative teaching*****. Josey-Bass: San Francisco.**

Perhaps the biggest challenge to developing mastery approaches to teaching in your school is that these pedagogies depend on the teachers' beliefs about intelligence and about the nature of mathematics as a subject (Boyd & Ash 2018a; 2018b). Benjamin Bloom and colleagues developed a framework for mastery learning in the 1970s (Bloom, 1971). In this body of work, mastery is presented as a philosophy about teaching founded on the assumption that 'under appropriate instructional conditions virtually all students can and will learn well most of what they are taught' (Block & Anderson, 1975 p.1). This stance seems to adopt a belief that intelligence is malleable (Dweck, 1999; 2006) and an approach that avoids labelling children (Hart et al., 2004). Mastery approaches to maths are entangled with mindset theory applied with the specific domain of maths teaching and learning (Boaler, 2016).

Many schools will be understandably cautious about moving quickly towards mastery approaches. Engaging with the flexible classroom strategies proposed by Jo Boaler may enable teachers to move their current practice towards mastery approaches. Applying a professional inquiry approach such as action research or lesson study will support classroom experimentation (Baumfield, Hall & Wall, 2015; Dudley, 2014). Some schools may move decisively towards mastery approaches and this is likely to include adoption of a text book scheme. Schools in all of the top performing countries in international mathematics tests depend on text book schemes (TIMMS, 2015). Adopting a text book based scheme includes a risk that some teachers may only engage superficially with the underpinning pedagogy and may resist the changes in beliefs associated with adoption of a mastery approach. Again, professional inquiry through action research or lesson study will help to underpin the adoption of a text book scheme and develop more secure critical understanding of the associated classroom strategies.

Jo Boaler's book is underpinned by extensive scholarship and supports the development of research-informed practice by teachers. This teacher guide links Jo Boaler's outstanding professional guide for maths teachers 'Mathematical Mindsets' to the key characteristics of mastery as outlined in the helpful NCETM (National Centre for Excellence in the Teaching of Mathematics) resource 'The essence of maths teaching for mastery' (https://goo.gl/GyRKhq). In each section below a key characteristic of mastery approaches is taken from the NCETM document and presented in **bold**. Each characteristic is discussed briefly and the reader is directed to relevant chapters of Jo Boaler's book for further reading and practical classroom strategies.

NCETM characteristic 1: Teaching for mastery rejects the idea that a large proportion of people 'just can't do maths'. Teachers and pupils engage with cultural beliefs about the nature of maths as a subject and its multidimensionality: maths is not about speed, calculation and finding a perfect solution. There are different ways to be good at maths, including asking good questions, rephrasing problems, explaining, using logic, justifying methods, using manipulatives, connecting ideas, helping others (Boaler 2016, p.122). Understanding the nature of maths as a subject that is open to all, explicitly valuing conceptual understanding and problem solving as well as computational and procedural skills, addressing the myth of the mathematically gifted child, and implementing equitable strategies will all contribute to a mastery approach (Boaler, 2016; Dweck 1999; 2016; Hymer & Gershon 2014). **This characteristic of mastery approaches links strongly to chapters 3 and 6 in Jo Boaler's 'mathematical mindsets' book. It is also captured in the concluding chapter 9 'Teaching Mathematics for a Growth Mindset'.**

NCETM characteristic 2: All pupils are encouraged by the belief that by working hard at maths they can succeed. Teachers and pupils engage with underpinning beliefs about growth mindset in maths: the more you practice (at the edge of your current level of performance) the smarter you get. This means that struggle and mistakes are our friend because they increase the possibility that we are learning at the edge of our current level of performance. The underpinning belief and adoption of a growth mindset, by the teacher and their pupils, arguably creates an essential basis of high expectations for all pupils as required for a mastery approach to maths. **This characteristic of mastery approaches links strongly to chapters 2 and 4 in Jo Boaler's 'mathematical mindsets' book. It is also captured in the concluding chapter 9 'Teaching Mathematics for a Growth Mindset'.**

NCETM characteristic 3: Pupils are taught through whole-class interactive teaching, where the focus is on all pupils working together on the same lesson content at the same time. The intention is that all pupils master concepts before moving on in a planned curriculum sequence. The lesson design identifies the maths to be taught, the key points and a how it fits into a carefully sequenced journey through the learning. Interaction, questioning, short tasks, explanation, demonstration, discussion. In acknowledging that teachers will be currently using a variety of approaches and formal schemes, Boaler develops 'complex instruction' as a suitable approach to lesson design and teaching (Boaler, 2016: p.115). Different schemes, such as those influenced by South Asian approaches, propose varied lesson structures, but it seems appropriate to consider lesson design as a way to support teachers in moving towards mastery approaches. This element of mastery challenges existing beliefs and practices around grouping, differentiation by task and the ideas of pace and progress influenced high stakes inspection in England. This issue of what a mastery approach lesson looks like seems important and is a practicable to work with teachers. **This characteristic of mastery approaches links strongly to chapter 7 in Jo Boaler's 'mathematical mindsets' book. It is also captured in the concluding chapter 9 'Teaching Mathematics for a Growth Mindset'.**

NCETM characteristic 4: If a pupil fails to grasp a concept or procedure, this is quickly identified and early intervention ensures that the pupil is ready to move forward with the whole class. Early intervention is used to support pupils who have not grasped a concept or procedure so that they are ready for the next lesson. This aspect of mastery approaches will require other aspects of mastery approach, such as mindset, multidimensionality, and collaborative working in 1,2 and 3 above to be in place because otherwise the wrong children and perhaps the same children each time, will be identified as needing intervention. In addition, a practicable daily routine and staffing need to be in place. Setting up a suitable intervention approach will benefit from careful attention to equity and some school to school sharing of practice. **This characteristic of mastery approaches is not addressed in Jo Boaler's 'mathematical mindsets' book.**

NCETM characteristic 6: Procedural fluency and conceptual understanding are developed in tandem. This has implications for lesson planning and in particular for the design of problems and the accompanying supported practice and deep practice exercises. Boaler acknowledges the variation in starting points and current resources that teachers will face and looks at task redesign from whatever existing resources are available. This seems a considerable challenge for teachers without a suitable commercial package of resources. **This characteristic of mastery approaches links strongly to chapter 7 in Jo Boaler's 'mathematical mindsets' book.**

NCETM characteristic 7: It is recognised that practice is a vital part of learning, but the practice used is intelligent practice that both reinforces procedural fluency and develops their conceptual understanding. This means that the practice element of a lesson should be carefully designed, if necessary adapted from the curriculum being used to become more open. Boaler suggests six methods of redesign: opening the task to encourage multiple methods, pathways and representations; making it into an inquiry task; asking the problem before teaching the method; adding a visual component; making it low floor and high ceiling; adding the requirement to convince and reason. **This characteristic of mastery approaches links strongly to chapter 5 (particularly to pages 76 to 91) in Jo Boaler's 'mathematical mindsets' book. It is also captured in the concluding chapter 9 'Teaching Mathematics for a Growth Mindset'.**

NCETM characteristic 8: Significant time is spent developing deep knowledge of the key ideas needed to underpin future learning. The structure and connections within the maths are emphasised to sustain deep learning. This element particularly challenges current beliefs and practices for pupils with higher prior attainment. Teachers may need 'permission' not to move on quickly to new tasks and topics with their higher attaining pupils. Another aspect raised concerns the maths subject knowledge of non-specialist classroom teachers. Teachers will need support to grasp the deep learning, structure and connections related to a particular lesson or sequence of lessons. It is very challenging to design or select problems on which to base a lesson and it is also difficult to design appropriate practice tasks that include suitable variation and challenge. Most teachers, especially if they are not maths specialists, will require the support of a well-designed scheme and it is sufficient challenge for them to engage and understand the scheme and develop their subject knowledge through that engagement. **This characteristic of mastery approaches links strongly to Case 4 pages 69 to 71 and then to chapter 9 'Teaching Mathematics for a Growth Mindset' (especially pages 180 onwards).**

NCETM characteristic 9: Key facts such as multiplication tables and addition facts are learned to automaticity to avoid cognitive overload in the working memory and enable pupils to focus on new concepts. In some ways Jo Boaler appears to disagree to some extent with the complete emphasis on automaticity in this statement from the NCETM. She seems to agree to some extent on developing automaticity but through games rather than rote learning and testing, and she appears to emphasise the development of mental flexibility as superior to memorisation. In chapter 4 Jo Boaler provides a useful section on developing key facts and number sense and recommends little and often. In an open access article (https://www.youcubed.org/fluency-without-fear/) she argues that automaticity means more than speed and memorization. We have plenty of expertise within the cluster on automaticity. It seems interesting to consider how approaches to automaticity might contradict other elements of a mastery approach, for example by emphasising speed and calculation. It seems interesting to consider how fluency and conceptual understanding can be developed in tandem if automaticity is a pre-requirement for problem-solving. **This characteristic of mastery approaches links strongly to chapter 4 in Jo Boaler's 'mathematical mindsets' book.**

An Australian study of student engagement in mathematics suggested that: 'A good start appears to be a focus on school caring, mastery oriented classrooms and teachers enthusiastic about teaching mathematics' (Watt, Carmichael & Callingham, 2017: p.178). Put simply, in order to set themselves mastery (learning oriented) goals in maths lessons, students need to feel that they 'belong' and that they are 'safe'. Lack of a positive learning environment in your classroom is likely to undermine evidence-based interventions (Marshall & Drummond, 2006). This need to develop a learning environment in which collaboration is valued and struggle and mistakes are welcomed as learning opportunities may be characterised as 'teaching mathematics for a growth mindset' (Boaler, 2016 p.171).

Whilst there is considerable variation, due to differences in approach or to local differences between teachers and schools, mastery approaches to maths, including the English curriculum with its support network, South Asian approaches including Maths - No Problem! and the approach of complex instruction adopted and developed by Jo Boaler, appear to share the following broad characteristics:

- The whole class, of mixed prior attainment, moves through the curriculum at the same pace
- The curriculum is focused on core knowledge and not too content heavy
- Teachers believe that virtually all children can and will learn and succeed in maths
- The lesson begins with a contextualised problem and whole class exploring
- There is interactive dialogue as a whole class and in mixed pairs
- The problems are at least to some extent grounded in the real world and may be authentic
- There is considerable use of concrete materials, manipulatives, at least at early ages
- Mathematical variation, with careful design of examples, is emphasised throughout

There seems to be considerable variation between the different mastery approaches concerning the selection of a suitable 'problem' as a basis for a lesson and for exploration through whole class teaching. The design of practice tasks also seems to vary considerably.

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