PROBLEM-SOLVING EXAMPLES FOR DEVELOPING MASTERY IN KS1

NATURE OF THE ACTIVITIES SUGGESTED HERE

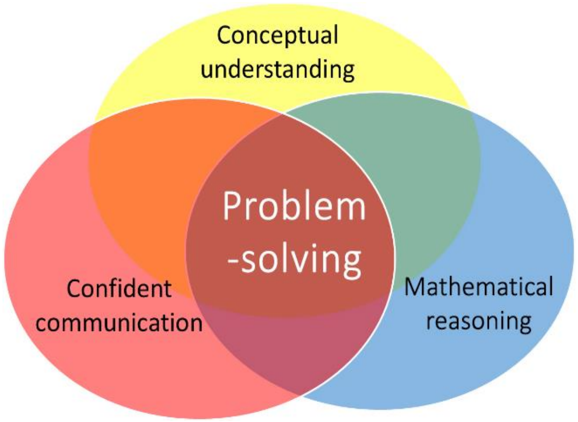
With the surge of interest and sometimes confused interpretations of what is meant by ***Mastery*** in mathematics, a number of different claims have been made about what it means and what is required. The efficacy of different approaches to implementing a Mastery approach to learning mathematics in the primary school, as demonstrated by higher performing jurisdictions in the Far East, as measured by PISA* and TMSS* have been questioned and challenged.

However, there are some essential points that appear to be in common when examining different approaches.

Research in mathematics education, which curriculum developers and educationalists in the Far East have used, have been known for many years and including Bloom's* theories of *Mastery,* the development of *deeper conceptual understanding* through a progression in *Concrete-Pictorial-Abstract (CPA)* experiences, first discovered by Bruner*, the *realistic mathematics education* of Freudenthal*, and the seminal *Cockcroft Report*,* particularly, its emphasis on the importance of *practical experiences* and *problem-solving*. More recently, Lo's* research in the subject of *Variation Theory* has been prominent in exploring how to plan learning for understanding through small steps in conceptual and procedural variation when teaching.

All of these principles have informed the sample of activities presented here. Proponents of Mastery in mathematics (e.g. Drury*) also argue that teaching and learning must focus on enabling children to develop ***rich connections*** between different facets of their mathematical experience and learning. These aims are also highlighted in the 2014 National Curriculum Aims*. The diagram below shows how these facets are all inter-related, and how teaching to connect these is crucial to ***deeper mathematical learning.***

Hence, the activities suggested here are designed to promote the following:



- practical activity manipulating concrete resources where possible;
- working in pairs or groups to encourage the confident use of the language of mathematics through explanation and reasoning with other children;
- ensuring that formal written arithmetic develops from secure experiences with concrete, visual and mental understanding of the manipulation of number and the arithmetic operations;
- solving problems (or by playing games) with the potential for a useful or pleasing result;
- opportunities for finding more than one acceptable result, which children can compare and discuss through collaboration or (guided) peer-assessment.

There is an expectation that discussion and exploration of misconceptions or errors is a healthy and productive feature of the classroom and that children are encouraged to explain their thinking and listen to others.

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In some of the activities, it could be argued that a written sheet of exercises could be given to produce similar results. However, the use of concrete apparatus and visual images provides a medium for discussion and helps to establish a rich conceptual understanding, which is often insufficiently developed through an abstract engagement with written exercises alone. In other cases, children are using equipment to generate the problem to be solved, so can be more engaged in its solution.

Where it is suggested pairs or groups of children work together, the groups may of course be varied to suit the teacher's own judgement. For example, in a game intended for pairs, an odd number of children can be accommodated by a changing combination of 2 vs 1.

To make it more accessible when reading the description of the activities, children's names have been used to identify the sequence of interactions between learners working in pairs or groups.

For every activity, it is paramount that the teacher teaches by modelling the activity with the class, so that children see and imitate what they need to do. Simply providing a written instruction sheet or verbal series of instructions is insufficient for the children to understand and engage with most activities.

Each activity has suggestions for extending or simplification. The expectation is that each can be explored comprehensively within one classroom lesson of 45 minutes or more.

For more information about improving the capacity for teaching and learning mathematics in the primary school, visit www.MathematicsMastered.org

*References

Bloom, B. S. (1971) 'Mastery learning', in J. H. Block (ed.), *Mastery Learning: Theory and Practice*, New York: Holt, Rinehart & Winston

Bruner, J. S. (1960) *The Process of Education*, Cambridge, Mass.: Harvard University Press.

Cockcroft, W. H. (1982) *Mathematics Counts,* London: HMSO.

DfE (2013) 'Mathematics', in *National Curriculum in England: Primary Curriculum*, DFE-00178-2013, London: DfE.

Drury, H. (2014) *Mastering Mathematics*, Oxford: Oxford University Press.

Freudenthal, H. (1991) *Revisiting Mathematics Education – China Lectures*, Dordrecht: Kluwer.

Lo, M. L. (2012) *Variation Theory and the Improvement of Teaching and Learning*, Gothenburg studies in educational sciences 323, Gothenburg University.

Programme for International Student Assessment (PISA), [Organisation for Economic Cooperation and Development (OECD)]

Trends in International Mathematics and Science Study (TIMSS), [International Association for the Evaluation of Educational Achievement (IEA)]

22. Perimeter, Area and Volume **Developing early understanding of perimeter as a measurement of length in non-linear situations.** **To measure length using a unit of 1 metre.** Children explore the notion of perimeter as the length of the complete boundary around a given space. Even young children can understand that fences which surround fields, or other spaces, have to be measured, so that we know how much we need.	**How much fencing?** Children work in groups of 2–4. Each groups will need access to: • 'Clicking' trundle wheel; • Metre stick. Mark out some prospective spaces with (P.E.) space markers or cones before the lesson. Explore the idea that there may be suggestions for the use of space outside the school buildings, which may need to be enclosed with fencing or for some other reason: for example, a new environmental area, a small garden or allotment, the school playing field, the playground itself, a children's patio, and so on. Show the children how a trundle wheel is used to measure 1 metre and demonstrate its equivalence to a measure of 1 metre using a metre stick. It is very helpful to have a trundle wheel which clicks every metre, as the children can count the number of clicks. Show the children how the trundle wheel could be used to measure a *perimeter.* It is ok to use this term – just help the children to understand that it is a measure of the length all the way along a boundary. Show how to measure the (approximate) perimeter of the classroom, say. Count the clicks and agree with the children the perimeter of the classroom to the nearest metre. Set out some P.E. space markers to mark an approximate rectangle or other large polygon on the floor. How long would a fence around the shape need to be? Help the children see how to traverse the boundary of this virtual shape with the trundle wheel to measure its perimeter. Emily, Luke, Kasia and Nathan, then go outside and measure the spaces to be enclosed for themselves. At this stage, do not worry about stopping at corners, just turn and continue when needed. All measurements can be approximate.	Do children see the equivalence between one turn of the trundle wheel and the straight length of the metre stick? Do the children understand that the perimeter is simply a measure of the distance around the boundary of a space? Do they traverse the boundary of the shape carefully? Do the children use the trundle wheel and count the number of metres correctly?