PROBLEM-SOLVING EXAMPLES FOR DEVELOPING MASTERY IN KS1

NATURE OF THE ACTIVITIES SUGGESTED HERE

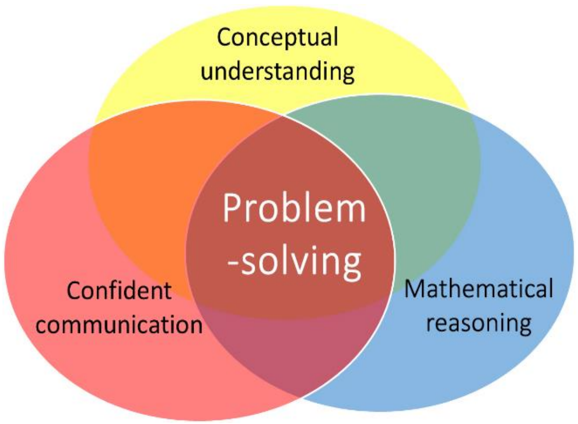
With the surge of interest and sometimes confused interpretations of what is meant by ***Mastery*** in mathematics, a number of different claims have been made about what it means and what is required. The efficacy of different approaches to implementing a Mastery approach to learning mathematics in 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.

NATURE OF THE ACTIVITIES SUGGESTED HERE

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.

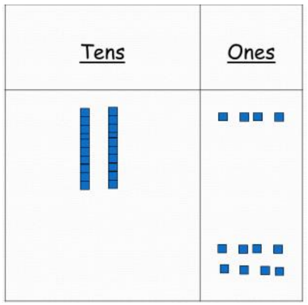
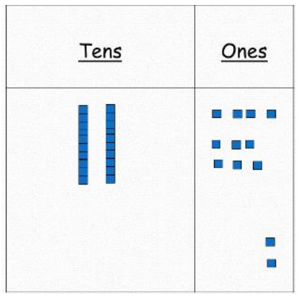
Drury, H. (2014) *Mastering Mathematics*, Oxford: Oxford University Press.

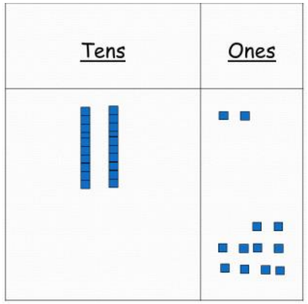
Freudenthal, H. (1991) *Revisiting Mathematics Education – China Lectures*, Dordrecht: Kluwer.

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)]

9. Written Methods for Addition and Subtraction **Recall and use addition and subtraction facts to 20 fluently, and derive and use related facts up to 100.** Rather than introducing formal vertical written methods in KS1, we advise that in working towards these, activities for years 1–2 concentrate on practising skills and understanding in the partitioning of numbers which are crucial for developing the formal vertical written methods in KS2.	**<u>Finding friendly pairs</u>** The teacher should demonstrate with some examples, then in pairs, children separate place value cards into two shuffled piles: *tens* and *ones* placed face down on the table. Emily takes one place value card from the top of each pile to make a two-digit number, for example 20 + 4 = 24 Luke takes the next p.v. card from the top of the pile of ones cards, for example, 8 Both children write down the addition sentence for these numbers: ***24 + 8 =*** On a place-value mat, using base-10 apparatus Emily sets out 24 as ***20 + 4*** and Luke sets out 8, below left (see photocopiable resources):  They must look for a way of using all or part of the ***8*** to add easily to all or part of the 24. For example, Emily decides to add 6 to the 4 to make 10, So she partitions the 8 and rearranges the ones as on the right:  She can then rewrite the addition as: ***20 + 4 + 6 + 2*** and regroup it as ***20 + 10 + 2***	Do the children see how they can use knowledge of number bonds to 10 to see how to look for complements to make a 10? In time, children should make the connection to extend the 10-complement facts to make the next multiple of 10 for any addition. Children can explain that the actual value of, say, three *tens (longs)* is 30 Children should see that visualising the expression of their calculation as ***20 + 2 + 10*** is completely valid, and that we go on to group the *tens* and the *ones* appropriately. When confident, children can set out and add a pair of two-digit numbers for sums less than 100.

	Luke decides to use the 8 to make 10, so he needs 2 from the 4, below left:  He can then rewrite the addition as: ***20 + 2 + 8 + 2*** and regroup it as ***20 + 10 + 2***. After exchanging 10 *ones* for 1 *ten*, they compare their calculations to see how both arrived at the result.