PROBLEM-SOLVING EXAMPLES FOR DEVELOPING MASTERY IN LKS2

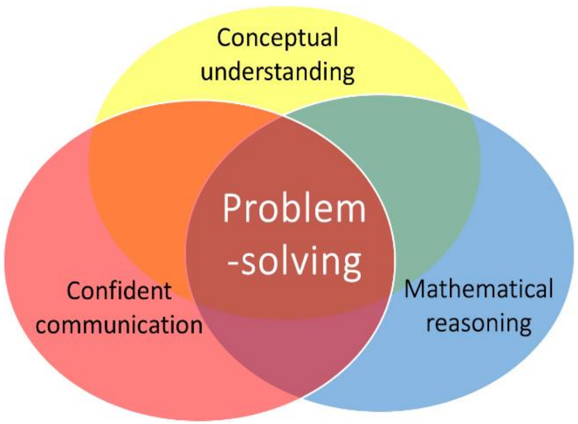
NATURE OF THE ACTIVITIES SUGGESTED HERE

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 which 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.

NATURE OF THE ACTIVITIES SUGGESTED HERE

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.

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.

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NATURE OF THE ACTIVITIES SUGGESTED HERE

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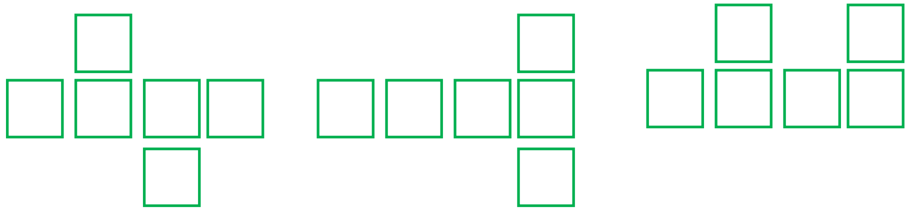
Lo, M. L. (2012) *Variation Theory and the Improvement of Teaching and Learning*, Gothenburg studies in educational sciences 323, Gothenburg University.

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)]

25. Classifying Shapes **To understand how a 3-dimensional polyhedron is constructed from a *net* of 2-dimensional faces.** **To use the vocabulary of 2- and 3-dimensional shape, e.g. *face, vertex, polyhedron, pyramid, prism, net, etc.*** This activity enables children to freely explore the creation and properties of 3-dimensional shapes from different nets.	<u>**Constructing nets**</u> In pairs. They will need: • A 3D shape construction kit, based on assembling 2D shapes, for example, Polydron Frameworks ©; • Plain paper (A3) for tracing the net of the faces. Begin with a display of different configurations of the net for a simple cube. For example:  Ask the class if all of these nets would fold to make a cube, and ask them to explain their thinking. Experiment with the construction kit to test which of these nets work and understand why some do not. Now set some challenges to use the construction kit to create specific 3-dimensional shapes and open up the nets for these. When the net is opened out and flattened, the children should draw around the (inside of *Polydron Frameworks*) faces in order to record the net which was used and name the polyhedron which they created. For example:	Do the children see that every 3D form comprising plane faces can be disassembled into a net? Do they realise that not every net will produce a 3D form? Can they begin to describe the conditions where a net will not do so? Do they realise that not all regular 2D shapes will produce regular polyhedra? e.g. hexagons. Do they realise that some 3D forms are created by a specific combination of two or more types of plane shape? For example, a football is typically 3D form comprising regular pentagons and regular hexagons in a repeated pattern:

	• Make a ***cuboid*** which is not a cube; • Make a polyhedron with 4 faces. What is it? • Make two different polyhedra with 5 faces. What are they? (square-based pyramid and triangular prism); • Make a pentagonal prism. Can you draw at least 3 different nets for it? • …and so on. Extend the challenge for children to create one of the more complex platonic solids, for example, an ***octahedron***, or even a ***dodecahedron***.	'32 panel or Telstar' – 12 Pentagons and 20 Hexagons