PROBLEM-SOLVING EXAMPLES FOR DEVELOPING MASTERY IN LKS2

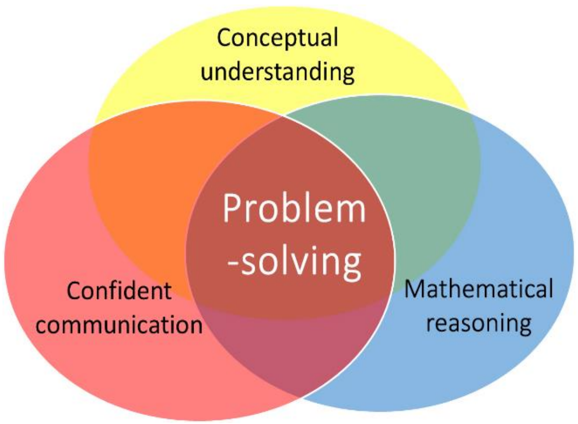
NATURE OF THE ACTIVITIES SUGGESTED HERE

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.

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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

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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)]

23. Angle **To recognise *acute, right, obtuse* and *reflex* angles.** **To explore different static angles in the context of 2-D shapes.** A practical activity for children to explore different angles within shapes.	<u>**Zany angles**</u> Children work in pairs to discuss and compare findings. They will need: • Geoboards and rubber bands or 'Dotty' paper (1 cm^2 matrix). Introduce/revise the four different classes of angle; illustrate these with projected examples of each. Show how we refer to these to describe the internal angles of a 2-dimensional shape. Now ask Shelley and Rohan to use the geoboards to make different quadrilateral shapes (or draw these on 'dotty' paper). Challenge them to see if it is possible to make quadrilaterals in which the number of internal angles that are acute is (a) 4, (b) 3, (c) 2, (d) 1, (e) 0. Then to do the same for obtuse angles. Then do the same for reflex angles. Discuss why the impossible ones are impossible (for example, why is 'four acute angles' not possible? or 'two reflex angles'?). Compare and discuss findings as a whole class. Help the children remember terms: ***acute*** can be thought of as '*a cute* little angle'; ***reflex*** can be remembered as the angle of a bent knee – and associated with the child testing the *reflex* of their knee (tapping it just below the knee cap) when one leg is crossed over the other while seated. This activity could be extended by exploring the internal angles of other polygons in a similar way.	Do children correctly identify the internal angles of a shape as ***acute, right, obtuse*** or ***reflex*** angles as appropriate? Do children see that all quadrilaterals have internal angles adding up to a maximum of four right angles? Do children see that moving the sides of the shape to change one angle affects the two angles on each side of that one? If extending the activity, do children realise that the internal angles of other shapes add up to a different amount, e.g. for a triangle it is a maximum of two right angles?