PROBLEM-SOLVING EXAMPLES FOR DEVELOPING MASTERY IN LKS2

3-4

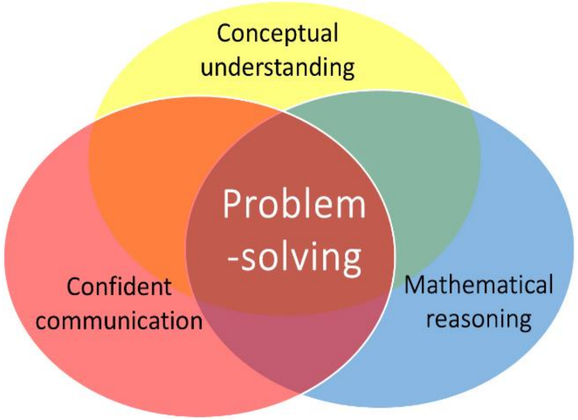
NATURE OF THE ACTIVITIES SUGGESTED HERE

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)]

28. Probability

To estimate a fraction based on probability.

Although *Probability* does not presently appear in the English Primary curriculum, it is a worthwhile and interesting area of mathematics for children, and it is included here as it is still featured in other international curricula. Probability is one of the most important areas for using and applying mathematics in real life. It is a key part of our mathematical skills to respond to life's chance events with intelligent strategies based on our understanding of probability.
This activity will tie in with the children's developing understanding of fractions of a set.

<u>**Probable proportions**</u> Children work in groups of 3 or 4. They will need:

- A prepared tally chart for the group. (See photocopiable resources);
- A bag containing 12 counters in specific proportions of different colours.

To begin with, the bag contains 4 colours, with 3 counters of each colour. Shelley, Rohan, Alice and Marek are told that there are 12 counters, but not how many colours or the numbers of each colour there are. The children take turns to draw a counter from the bag and tally it in the chart, then return it to the bag before the next child's turn. After a number of draws, the tally chart may appear like this:

Colour	Tally	Total
red	卌 卌 |||	13
yellow	卌 卌 卌	15
green	卌 卌 ||	12
blue	卌 ||||	9

Ask the children to discuss between them what they would estimate to be the proportions of counters of each colour in each bag. Then let them draw a counter in turn without replacing it to see the actual proportions of the different colours.

Next provide different bags with a *known total* number of counters and *known proportions* but not revealing which colour is which fraction. For example:

There may be 5 red counters, 5 blue counters and 10 green counters. Tell the children there are 20 counters in total, and that the proportions of different colours are ½, ¼ and ¼.

Shelley, Rohan, Alice and Marek draw and replace counters in turn, tallying their findings and then agree which colour has been assigned each proportion.

Do the children use the language of probability in discussing strategy: ***more likely, less likely, certain, impossible***, and so on?

Can the children identify the colours assigned to each proportion without knowing the total number of counters? Does it make any difference know this?

Do the children realise they need to collect a lot of data before they can be sure of a reasonable level of accuracy?