# PROBLEM-SOLVING EXAMPLES FOR DEVELOPING MASTERY IN LKS2

3-4

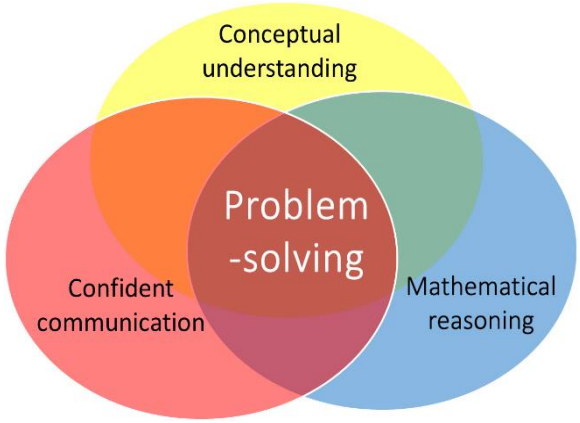
## NATURE OF THE ACTIVITIES SUGGESTED HERE

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.

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.

## NATURE OF THE ACTIVITIES SUGGESTED HERE

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)]

| | | |
|---|---|---|
| **16. Decimal Numbers and Rounding**<br><br>**Estimate to check answers to a calculation.**<br><br>**Round decimals to the nearest whole number.**<br><br>**Estimate and calculate money in pounds and pence.**<br><br>When dealing with sums of money combining both £s and pence, it is very useful to be able to estimate the final amount in order to be sure that a mistakes is not made. It's often helpful to round amounts to the nearest pound. This enables a reasonably good estimate to be made simply from adding up a number of whole pounds. | **Rounding to estimate** After demonstration, children work in pairs. They will need:<br><br>• Menu of items to select in a café, for example, the Cosy Café menu (in the photocopiable resources):<br><br>*The Cosy Café*<br><br>*Savoury*<br>*Sandwich* £1.95 *Baguette* £2.75<br>*Tortilla wrap* £1.45 *Pizza slice* £2.10<br><br>*Sweet*<br>*Scone and jam* £2.10 *Cake* £2.90<br>*Shortbread* £1.25 *Tiffin* £1.75<br><br>*Drinks*<br>*Squash* 95p *Juice* £1.35<br>*Tea* £1.65 *Coffee* £2.15<br><br>In this activity Shelley and Rohan practise how to make suitable estimates before they add amounts of money, and see how close the estimate was to their calculation.<br><br>First model, with the class, how to choose a helpful or 'friendly' number to which they can round an amount. For example, when adding say, £1.20 and £3.65: £1.20 is nearer £1 than £2, while £3.65 is nearer £4 than £3. Thus, a reasonable estimate would be £1 + £4 = £5. The addition of the actual amounts would of course be £4.85.<br><br>Now Shelley and Rohan each choose two items from the menu. | Do they round up or down individual items to the nearest whole pound correctly?<br><br>Do children understand that an estimate is not intended to be exact, but should be close enough to the amount to enable a reliable estimate?<br><br>Do they realise that the maximum difference between the actual and rounded amount in each case can be no more than 50p? In the case of adding two items do they see that the final answer should be less than £1 different (50p + 50p) to the estimated answer?<br><br>How should they round an amount which is, say £1.50? Does it makes sense to round this or not? |

| | | |
|---|---|---|
| | • They first round the price up or down as appropriate to write their estimate of the total in each case, then carry out the addition, using whatever informal or formal written method they are currently practising;<br>• If there is a difference of more than £1 between their estimate and the answer they need to check the calculation, possibly by an inverse calculation (subtraction), and then check their estimate again;<br>• They repeat this for different combinations from the menu.<br>The estimates and calculations can be extended by selecting three or more items from the menu. It is also possible to round items to the nearest 50p, so that £1.65 is rounded to £1.50. This will help make estimates more precise. | |