# PROBLEM-SOLVING EXAMPLES FOR DEVELOPING MASTERY IN KS1

1-2

## NATURE OF THE ACTIVITIES SUGGESTED HERE

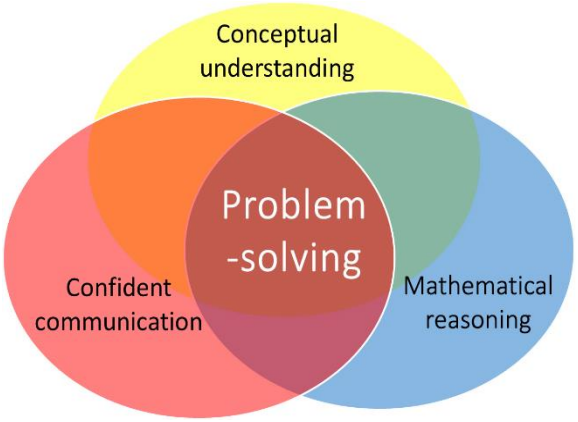
With the surge of interest and sometimes confused interpretations of what is meant by ***Mastery*** in mathematics, a number of different claims have been made about what it means and what is required. The efficacy of different approaches to implementing a Mastery approach to learning mathematics in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

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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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Trends in International Mathematics and Science Study (TIMSS), [International Association for the Evaluation of Educational Achievement (IEA)]

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| **8. Mental Strategies for Addition and Subtraction**<br><br>**Mentally add and subtract one-digit and two-digit numbers to 20 (and beyond!)**<br><br>**Represent and use number bonds and related subtraction facts within 20.**<br><br>This activity is a *real life* use of money: that of selecting appropriate coins to combine to make a specified amount. | **Loose change** This activity requires the following resources for the children to use:<br>• Tray of coins of different denominations 1p, 2p, 5p, 10p;<br>• Number of classroom items labelled with different prices from 3p to 20p, for example: book, pencil, ruler, etc.<br>Ask children to choose an item to buy and then select the fewest coins needed to pay the exact price for each item in turn.<br><br>They write the number sentence which represents the sum of the coins. For example, for a pencil costing 9p, Luke writes:<br>5p + 2p + 2p = 9p<br><br>When they have written their sums for each price the group explain their answers to each other in groups of 2–4 as a simple form of peer assessment.<br><br>A desktop number line can be used to support calculation (numbered 1–20 is sufficient)<br><br>As an extension, children can be asked to find alternative combinations of coins to make the same price (not just the fewest).<br><br>Challenge the children by reducing the available denominations, for example: just 1p, 2p and 5p.<br><br>The activity can be modified as needed by limiting or extending the range of prices. | Can the children make up an aggregate sum of money from the available coins to reach the required value?<br><br>Do the children recognise that there is a one to many relationship between different values of coin?<br><br>Can they make a correct substitution of other coins for one coin?<br><br>Do they try to find the highest available coin denomination to reduce the number of coins they need?<br><br>Do they add each additional amount correctly from the previously accumulated value?<br><br>When they have a partial value, can they subtract by counting on/back to find the remaining amount to make? |