PROBLEM-SOLVING EXAMPLES FOR DEVELOPING MASTERY IN KS1

NATURE OF THE ACTIVITIES SUGGESTED HERE

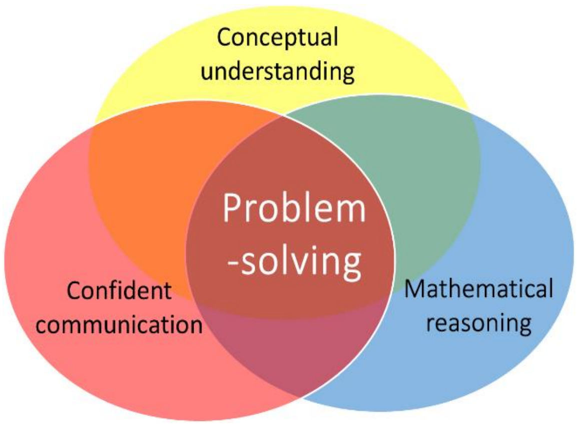
With the surge of interest and sometimes confused interpretations of what is meant by ***Mastery*** in mathematics, a number of different claims have been made about what it means and what is required. The efficacy of different approaches to implementing a Mastery approach to learning mathematics in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

14. Integers: Positive and Negative **Understand ordinal use of number can be extended to negative numbers.** **Read and interpret temperature scales.** Temperature is a real-life context in which we can introduce KS1 children to positive and negative whole numbers in a meaningful way.	<u>**Temperature check**</u> An on-going activity, a regular observation to carry out with the whole class. You will need: • Large classroom number line: if possible, a vertical line with a range of at least –10 to (+)30; • Two large, easy-to-see, air-temperature thermometers. Rather than one in-depth specific lesson, it is helpful to introduce children as early as possible to the everyday use of a thermometer to measure temperature. In the UK, temperatures rarely exceed a range of between -10°C to (+)30°C, so it is a practical exercise to record the inside and outside temperatures each day as a real-life exercise in mathematical/scientific data-gathering. It helps to hang two separate thermometers that can be briefly compared side by side, but do not risk the outside thermometer changing its value if it is very sensitive, so it may be that you read it *in situ* with different volunteers each day. Use the inside thermometer to help the whole class learn to count along the unmarked divisions to the temperature indicated. Use the large classroom number line to mark the inside and outside temperatures, and then together find the difference (*comparison* structure of subtraction) between them. Record publicly the two temperatures and the difference between the temperature inside and outside. Make comparisons between different days of the week. Use the number line to illustrate differences in an informal, visual way. On very cold days of course, we can naturally introduce even young children to the idea of negative numbers, and they may hear this on TV and radio (although the word 'minus' is used). It is also a very natural way to help them see that you can find the difference between a positive and a negative number, by seeing the visual space between them on the number line. This is very helpful to see the difference between, say, +1°C and -1°C!	It does not matter at this stage that children may not know what is actually meant by degrees, just that they see that we measure temperature in degrees, just like we measure money in pence, and length in metres. Do the children realist that in this context 0°C does not represent the *absence* of temperature (or heat)? Do they see that 0 is simply a point in ***ordering*** the values of temperature, from which we count numbers positively in one direction (getting warmer) and negatively in the other (getting colder)? Can the children see the ***difference*** between two temperatures as the numerical 'space' between them on the number line, regardless of whether the temperatures are positive or negative values?