PROBLEM-SOLVING EXAMPLES FOR DEVELOPING MASTERY IN KS1

1-2

NATURE OF THE ACTIVITIES SUGGESTED HERE

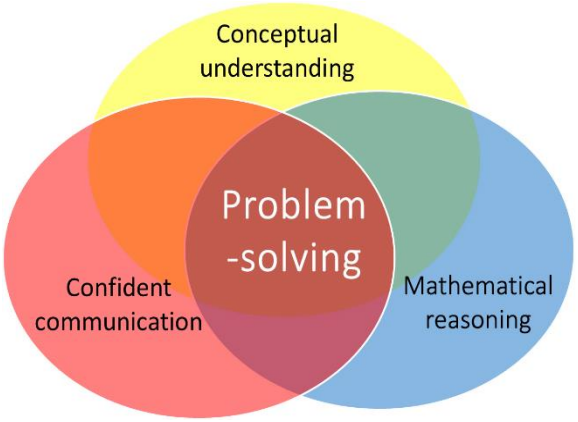
With the surge of interest and sometimes confused interpretations of what is meant by ***Mastery*** in mathematics, a number of different claims have been made about what it means and what is required. The efficacy of different approaches to implementing a Mastery approach to learning mathematics in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

NATURE OF THE ACTIVITIES SUGGESTED HERE

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

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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.

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

28. Probability

To experience the equal probability of events involving symmetrical outcomes.

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.

(To use a *tally* chart to organise data received in an unsorted order – c.f. activity for Chapter 26.)

Snakes and Ladders Children work in small groups of 3 or 4. They will need:

- A single prepared chart for recording the tallies (See photocopiable resources);
- *Snakes and ladders* game board, a single die and a different coloured counter for each player.

Simple *chance* games with playing cards such as *Snap* and *Beat your neighbour out of doors* and simple dice games such as *Snakes and Ladders* help children begin to experience chance from an early age, though unfortunately, often acquiring some wrongly established intuitive ideas along the way! Often children's *subjective* experience of throwing a die – when they require a *six* in order to start – is that it is harder to get a *six* than any other number! The problem is, of course, the heightened emotional attachment the child has to the outcome, hence previous unpleasant experience is more likely to be recalled. This activity is to help to dispel such false notions.

Emily, Luke, Kasia and Nathan play a game of *Snakes and ladders* with a difference. At every throw they record in the *same* tally chart the number shown on the die, thus using their game to collect data from their experiences of throwing the die. For example:

Number	Tally	Total
1	𝍸 𝍸 𝍸 ||||	19
2	𝍸 𝍸 𝍸 |	16
3	𝍸 𝍸 ||||	14
4	𝍸 ||||	9
5	𝍸 𝍸 |||	13
6	𝍸 𝍸 𝍸 |	16

After different groups of children have played and collected a reasonable number of throws, collect and display the accumulated totals from all the groups for each number, and discuss the data with the children. It should become clear that in practice the number of throws will not be the same for each number, but that *six* is not a particularly disadvantaged number!

Do the children see that the frequency of each number being rolled is reasonably similar across the numbers? For any particular number that may have occurred many fewer times, ensure that the children see data from another group where this was not the case.

See also the potential crucial points and barriers to understanding for tallying (Y1–2 activity for Chapter 26).