PROBLEM-SOLVING EXAMPLES FOR DEVELOPING MASTERY IN KS1

1-2

NATURE OF THE ACTIVITIES SUGGESTED HERE

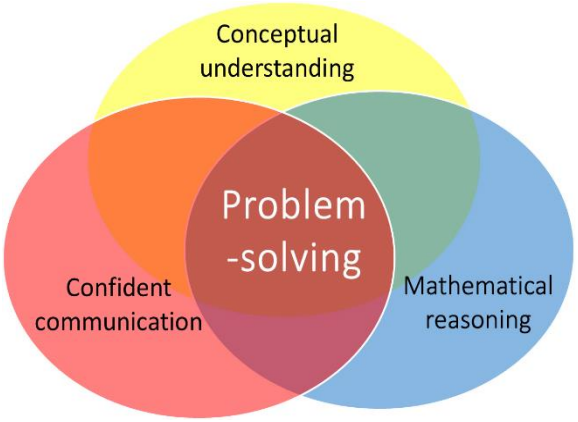
With the surge of interest and sometimes confused interpretations of what is meant by ***Mastery*** in mathematics, a number of different claims have been made about what it means and what is required. The efficacy of different approaches to implementing a Mastery approach to learning mathematics in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

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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Drury, H. (2014) *Mastering Mathematics*, Oxford: Oxford University Press.

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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)]

26. Handling Data **To use a *tally* chart to organise data received in an unsorted order.** The purpose of a tally chart is to sort data that is being received in an unpredicted order, so that it can be easily organised during the collecting phase. To demonstrate the tally chart's effectiveness to children, the data they collect needs to be arriving in this way too. Incorrect use of a tally chart is a common problem observed among trainee teachers, and sadly this is sometimes due to bad guidance in published schemes of work. I have seen children being introduced to tallies by counting the number of their peers, say, who walk to school, by a show of hands, which can be totalled at the same time, rendering the need for a tally chart redundant.	**Traffic survey** In small groups with an adult or as a whole class with additional adults to supervise as necessary. Each group will need: • Prepared charts for recording the tallies (see photocopiable resources); • Clipboards and spare pencils. An interesting example of the need for a ***tally chart*** is to carry out a traffic survey. Of course, this needs to be properly supervised if the children need to leave the school premises to carry it out; it may be most effective for a teaching assistant to take a small group at a time, with comparisons made of traffic at different times during the day; alternatively, the teacher could take the whole class with additional adult helpers to supervise groups at a safe place from which to observe passing traffic. In many schools an actively used road can be observed from within the school grounds. Set up the initial premise that the class has been asked to survey traffic to gather information for changes to routing or other forms of traffic management, such as where traffic lights and crossings need to be placed. Ask the children to discuss between them and identify the different categories of vehicles it may be helpful to count: *car, lorry, bus/coach, motorcycle, bicycle, van, tractor and 'other'* (just in case). Children write these categories in their chart. From a safe vantage point, children watch and tally observations into the different categories, for a fixed period, for example, 10 minutes.	Do the children realise they must make one stroke on the *correct* row of the tally chart for every vehicle they see? Do the children know how to make the fifth stroke on each tally as the 'bar' across the four previous strokes? Do they see how they can completed tallies help us to count up each category more easily in groups of 10s and 5s? Do the children realise there is no point in creating a tally chart if we can easily find out the total of each category without one?

Therefore, to show the use of a tally for 'journeys to school', ensure that the children ask their peers individually one at a time, so that the data arrives in an unpredictable order.

Upon their return, they count up their tallies and record the totals for each category, e.g.

Vehicle	Tally	Total
car	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 |||	33
lorry	𝍸 𝍸 ||	12
bus/coach	|||	3
van	𝍸 ||||	9
tractor	|	1
motorcycle	𝍸 |	6
bicycle	||||	4
other	|	1

There needs to be a meaningful discussion of their findings, as if preparing for a council transport meeting. Use the opportunity to teach/reinforce traffic awareness and road safety. Discuss the different vehicles:

- How many two-wheeled vehicles? (motorcycles + bicycles)
- How many were large vehicles? (lorries + buses)
- How many were small vehicles? (cars + vans)
- Why might there be more of some types than others?
- Were there any they did not see? Why?