PROBLEM-SOLVING EXAMPLES FOR DEVELOPING MASTERY IN LKS2

3-4

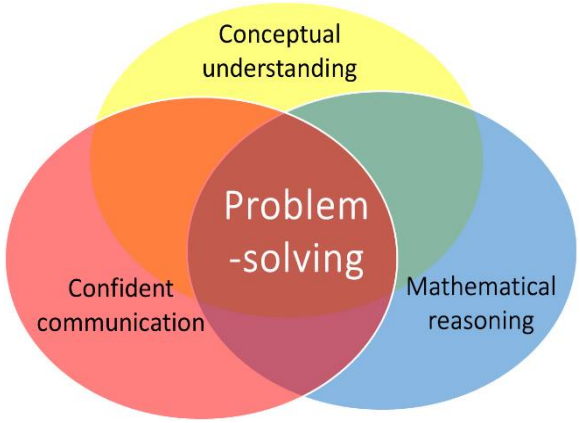
NATURE OF THE ACTIVITIES SUGGESTED HERE

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.

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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)]

26. Handling Data **To interpret and use and compare data from different bar charts and line graphs.** The time children spend collecting data and constructing bar charts and line graphs can be disproportionate with respect to the time they need to spend in learning to read, interpret and use data in graphical form to draw conclusions. This activity is a problem-solving exercise that requires the children to interpret and compare data from similar graphs.	**Dream holiday** Children work in pairs with: • PC/tablet for internet access to, or pre-printed, graphs/charts of temperature and rainfall for different locations around the world. You will need to research a range of potential holiday destinations with a variety of distributions of average daily temperature and rainfall patterns by month. You can find this information in travel or holiday guides for different places around the world. Most of this information is now available online, rather than having to acquire printed brochures, but sometimes for extracting suitable data the latter can be easier to manage. Travel websites are always changing, so it is not possible here to advise on any specific sites to use. Show an example of the distribution of average monthly temperature and rainfall for a particular holiday destination. Ask the children questions about this. For example: What is the average temperature in August? When is it hottest and what is the temperature? When is it coolest and what is the temperature? Which month has the most rain? And so on … Explain that you want to take your grandmother on a dream holiday. Then set some conditions. For example: She likes sunny places and hates wet weather, but she does not like it to be too hot – no more than 24^{o}C, nor too cold – not below 15^{o}C. You can only go during the Easter or Summer school holidays – give dates. Suggest some destinations to be investigated and ask the class to identify say, five, possible holiday locations and when it would be best to go there. Shelley and Rohan work together to make recommendations, ranking their solutions according to the key conditions.	Do the children interpret the graphs correctly? Commercial publications often show both temperature and rainfall graphs on the same outline. Since the graphs show average daily temperature and rainfall over time (a continuous variable) the data should be displayed in line graphs, but sometimes one will be represented as a bar chart. This is to help distinguish between the two charts when one is overlaid on the other. However it is a misuse of a format intended to represent data in a frequency table. Nonetheless, it is useful for the children to experience such 'real world' diagrams. You will, of course, need to help children find and focus upon the graphs and ignore unnecessary text presented to them.