PROBLEM-SOLVING EXAMPLES FOR DEVELOPING MASTERY IN LKS2

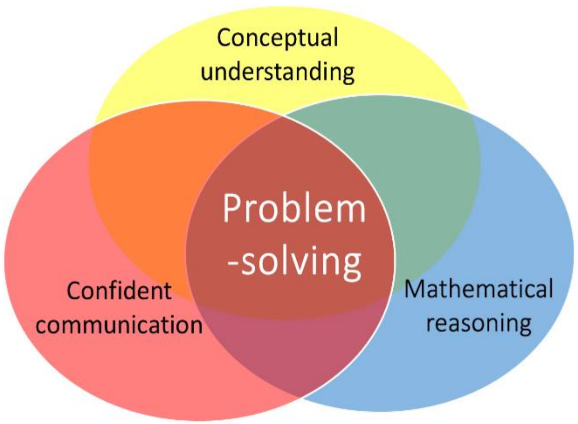
NATURE OF THE ACTIVITIES SUGGESTED HERE

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

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NATURE OF THE ACTIVITIES SUGGESTED HERE

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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)]

12. Written Methods for Multiplication and Division **Multiply two-digit and three-digit numbers by a one-digit number (leading to using a formal written layout).** **Recall and use multiplication and division facts for multiplication tables up to 12 × 12.** It is helpful for children to see that they can work out useful information from food packaging. This activity is intended to do that and provides a vehicle for practising written methods multiplication of TO × O and of HTO × O, typically the grid method to reinforce understanding of the distributive law at this stage. However, the multiplications required can be carried out by the current written method being practised.	<u>Nutrition labels</u> After demonstration, the children work in pairs to interpret the packaging. They will need: • A variety of collected food packaging with portion sizes and energy values: rice, pasta, cereals, milk, fruit juice are helpful. This can be shared by the whole class, taking and returning different items as needed. First display to the whole class an example of the nutrition information on one of the packets. Identify how to find serving size and the units used for this type of food – grams, millilitres, etc. Identify the *Nutrition* panel. This will usually describe the number of food calories or Calories (kcal or Cal) per serving or say, per 100 g or 100 ml. Model working out the food calories for multiple servings: 2, 3, 5, etc. Then set questions for the class to explore. For example: • Packets of rice and pasta typically suggest a 75 g (uncooked) portion per person. How much would be required to feed 9 people? • When it is cooked the same pasta weighs 170 g. How much cooked pasta would there be for 5 people? • Would 4 servings of pasta contain more calories than 3 servings of rice? • How many calories are present in 100 ml of semi-skimmed milk? (Typically about 49 kcal). If you had one serving of 100 ml every day for a week, how many food calories would you have had? (i.e. 7 × 49 kcal). • Compare typical portion sizes between different foods, e.g. 500ml of milk with 250g serving of a ready-meal. Which have more/fewer food calories than others? • Compare the values of other nutrition components – protein, carbohydrate, fat etc. Shelley and Rohan check each other's reading of the packets and their calculations. It can be simplified by restricting some pairs to working with packets displaying two-digit energy values. Other children can be challenged to work with three-digit energy values.	Do the children partition numbers correctly into *hundreds, tens* and *ones,* assigning the correct place value to each digit? Do the children have a secure understanding of how to apply the ***distributive law*** when multiplying parts of numbers together? Can the children explain the partitioning of two-digit and three-digit numbers, explaining how they have arrived at the resulting values of the partial multiplications? Can the children explain how the method they are using recombines the partial results to find the complete multiplication?