NATURE OF THE ACTIVITIES SUGGESTED HERE

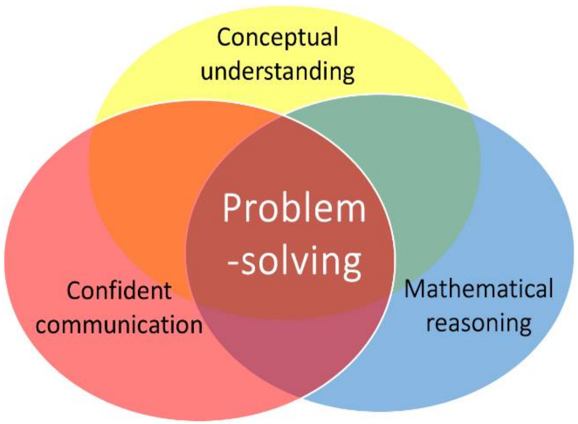
With the surge of interest and sometimes confused interpretations of what is meant by ***Mastery*** in mathematics, a number of different claims have been made about what it means and what is required. The efficacy of different approaches to implementing a Mastery approach to learning mathematics in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

PROBLEM-SOLVING EXAMPLES FOR DEVELOPING MASTERY IN KS1

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

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

25. Classifying Shapes

Recognise and name common 2-dimensional shapes.

Use the vocabulary to identify properties: *number of sides*, *number of vertices*.

A common misconception in children's recognition of shapes is that they often see very few *irregular* shapes*. Most manufactured shapes, whether in the built environment or simply plastic shapes provided for maths resources, are usually *prototypical*; that is, the shapes are either *regular* (equal sides and equal angles) or they are presented more frequently in one irregular form than any other (e.g. quadrilaterals as rectangles). If you do not have any *atypically irregular* shapes in your resources, make some by cutting from card or thin plastic, to show variation from the prototypical shapes available.

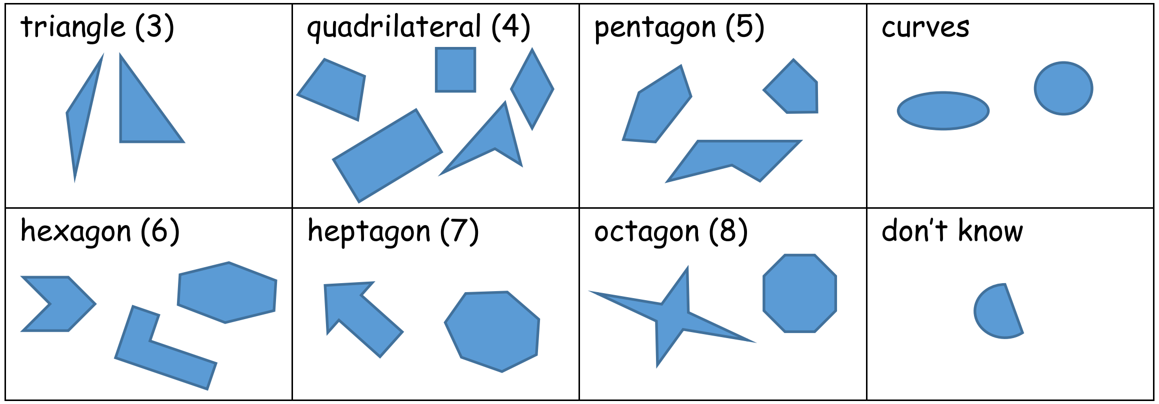
<u>Shape sorter</u> Children to work in groups of 3 or 4. They will need:

- Set of many prepared plastic or card shapes (N.B. see rationale);
- Large sheet of sugar paper divided into rectangles for classifying the shapes (see photocopiable resource to enlarge).

Tell the class you have had all your shapes muddled up and they need to be sorted so that you know how many of each type there are in the sets. Ask the children to think of ways in which they could sort them. Help the children to consider categories such as a particular number of (straight) sides: 3, 4, 5, 6 and so on. Help them to consider any shapes which have curves separately.

Display and say the names of specific polygons and the number of sides and vertices each has. Ask the children to write these in the 'boxes' on their sheet of paper. Ensure they also have a box for 'curves' and 'don't know'.

Emily, Luke, Nathan and Kasia must now work through their set of shapes, discuss and agree which box each shape should be placed in, and explain their reasons when asked.



Do children begin to sort shapes by properties such as number of sides and number of vertices?

Do they recognise that some prototypical forms are just special types of certain shapes? For example, a ***rectangle*** is a special type of quadrilateral, and that a ***square*** is a special type of rectangle.

When they see shapes which have curves – are any of these ***circles***? We might say that circles are 'as tall as they are wide'. Others will be ***ovals***. Some may have a combination of sides and curves. What would we call these? (For example, there may be a ***semi-circle***.)

*Hershkowitz, R. (1990) 'Psychological aspects of learning geometry', in Nesher, P. and Kilpatrick, J. (eds), *Mathematics and Cognition.* Cambridge: Cambridge University Press, pp 70–95.	The children's discussion should be able to describe the properties they have used to classify the shapes. As a class, you highlight some shapes which may be of specific interest and the 'don't knows'. Children enjoy exploring mathematical words, so don't worry about using 'big words' and providing some polygons of 8 or even more sides.	