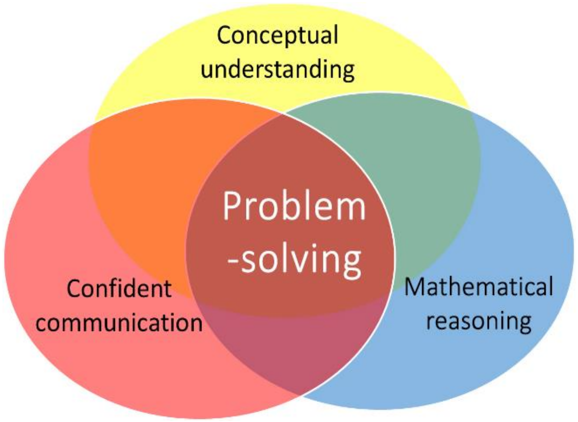
NATURE OF THE ACTIVITIES SUGGESTED HERE

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, that 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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Bruner, J. S. (1960) *The Process of Education*, Cambridge, Mass.: Harvard 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)]

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26. Handling Data

To interpret the *story* told by a graph, and draw conclusions from the data.

This activity is to challenge children in developing their skills in applying and using the data presented in graphical form.

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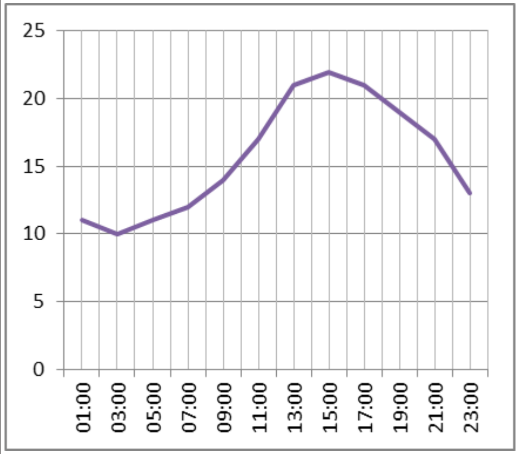
<u>**Data detectives**</u> Children work in groups of 3 or 4. They will need:

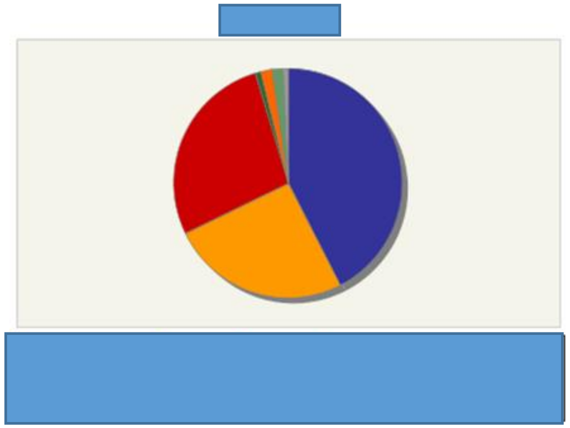
- Selection of different, but incomplete, graphs, so that the information presented may be subject to more than one interpretation or explanation (see photocopiable resources).

Show some simple untitled graphs with some missing labels and/or scales. For example:

A. Line Graph



B. Pie Chart



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Can the children in the group *convince* one another of the logical suitability of their explanation and their reasons for this? The children may have more than one valid explanation that fits the data.

Do the children know the important attributes and uses of each type of graph? When is it appropriate to use one type rather than another? Does this have an impact on the potential explanations for each? For example, only a graph with a continuous relationship between two variables should be represented by a line graph. Of these, showing a variable related directly to time is one of the most common uses.

Can children draw conclusions from the graphs according to their interpretation: what questions could each graph answer? For example:

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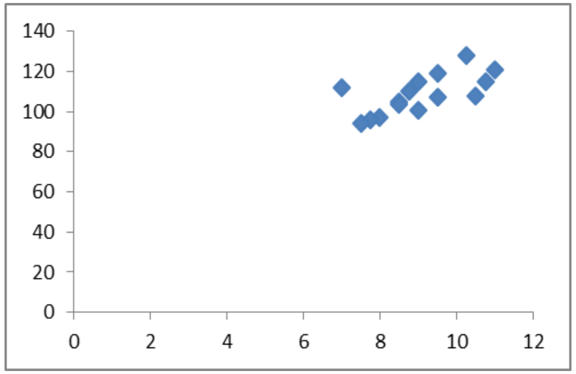
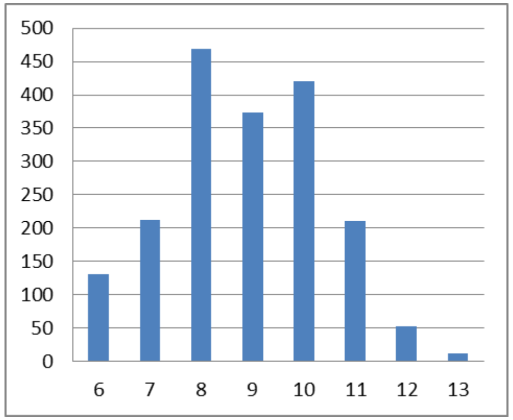
C. Scatter graph



D. Bar Chart



Meena, Charlie, Alexi and Woljca examine each graph in turn. They discuss and agree between them a convincing story for the data presented in the graph, and complete the missing title, label and scales.

The graphs invite the children come up with potentially more than one convincing story. For the record the originals are:

A. Line graph: temperature in °C recorded at different times over a 24-hour period.
B. Pie chart: Votes recorded for different parties at a general election: Labour – red, Liberal Democrat – yellow, Conservative – blue, then smaller parties grouped into other colours.
C. Scatter graph: relationship of age (year) to height (cm) for different children in a group.
D. Bar chart: Number of pairs (the ***frequency***) of men's shoes in different sizes sold by a shoe shop during the same period.

- Why is it warmest mid-afternoon, rather than when the sun is highest in the sky?
- Who won the election? If the pie chart represented the proportion of MPs each party has in Parliament could the governing party be outvoted?
- Do children grow steadily according to age? If so what would be the height/length of a baby when born? Does that make sense?