

# PROBLEM-SOLVING EXAMPLES FOR DEVELOPING MASTERY IN LOWER PRIMARY

1-2

## NATURE OF THE ACTIVITIES SUGGESTED HERE

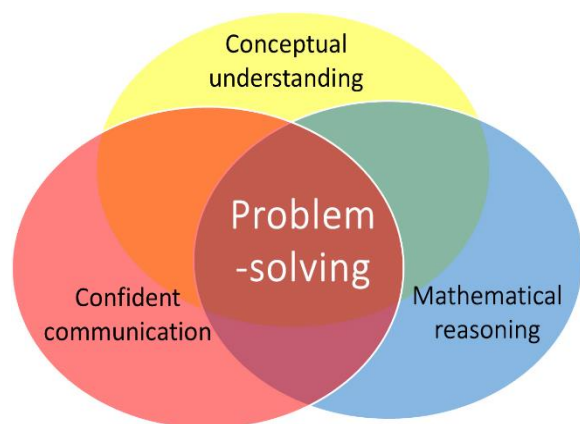
With the surge of interest and sometimes confused interpretations of what is meant by *mastery* in mathematics, different claims have been made about *mastery* and what is required. The efficacy of different aspects of mastery approaches to learning mathematics in the primary school, as demonstrated by higher performing jurisdictions in East Asia, as measured by PISA\* and TIMSS\* 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, already known for many years, has been used by curriculum developers and educationalists in East Asia, 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\*. 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. 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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## NATURE OF THE ACTIVITIES SUGGESTED HERE

In some of the activities, one may argue that a written sheet of exercises could 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](http://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.

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

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)]

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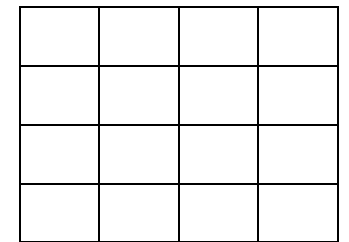
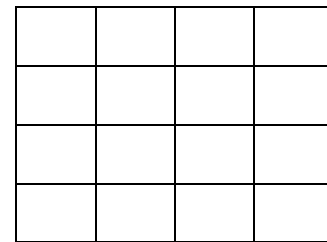
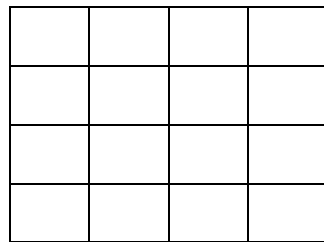
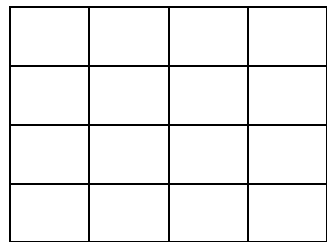
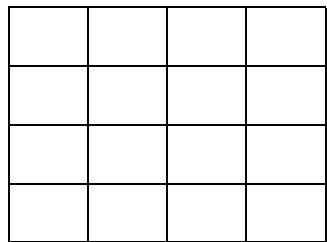
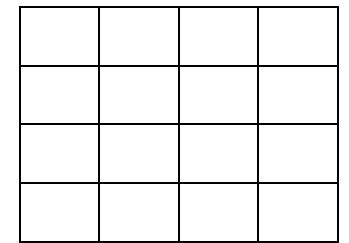
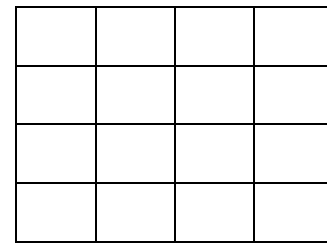
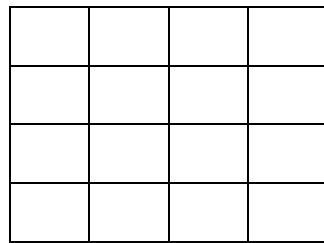
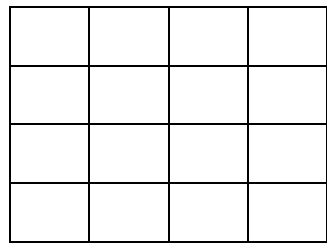
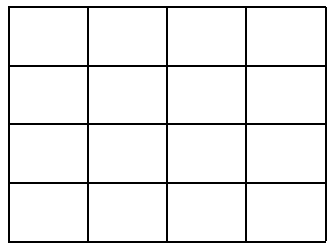
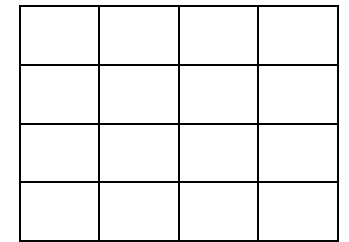
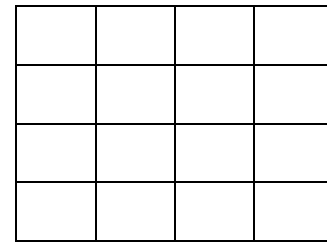
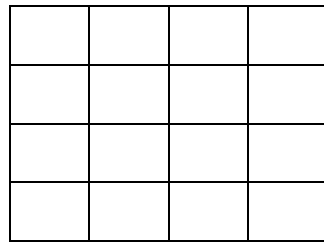
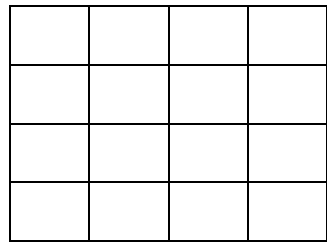
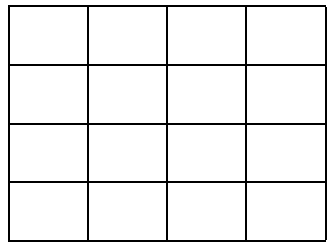
1-2

<p><b>7. Addition and Subtraction Structures</b></p> <p><b>Use the comparison structure to understand subtraction as the difference between two numbers.</b></p> <p>The example activities here focus on subtraction, as these structures are more difficult for children to understand than addition.</p>	<p><b>What's the difference?</b> The teacher first models this activity and then children work in pairs as partners. They will need:</p> <ul style="list-style-type: none"><li>• Multilink cubes in two colours (for example: 10 of each).</li></ul> <p>Luke and Emily agree which colour of multilink each will use. Without telling each other, each child takes a number of their cubes and makes a single column tower; for example, Luke makes a tower of 9 red cubes while Emily makes a tower of 3 green cubes.</p> <p>They place their towers side by side to compare them. Both children write this comparison as a <i>subtraction</i> number sentence, starting with the longer tower: <math>9 - 3 =</math></p> <p>They count the <i>extra</i> cubes found in the longer tower to find the <i>difference</i>. They agree what this is and then complete their number sentence with the answer: <math>9 - 3 = 6</math></p> <p>They repeat this several times.</p> <p>The activity can be simplified or extended by changing the number of cubes each child has.</p>	<p>Do the children ensure they align the base ends of the tower (for example, by placing both towers upright on the table)?</p> <p>Do they understand the term <b><i>difference</i></b> as a form of subtraction? Children's experiences of subtraction often focus upon <b><i>take away</i></b> (partitioning).</p> <p>Do they physically count on or count back correctly to identify the number of cubes which comprise the difference?</p>
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Hundreds	Tens	Ones

## SEEING SQUARES

Cut into separate grids – 1 for each child



# WORKSHEETS FOR LOWER PRIMARY

1-2

## 100-SQUARES

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

0	1	2	3	4	5	6	7	8	9
10	11	12	13	14	15	16	17	18	19
20	21	22	23	24	25	26	27	28	29
30	31	32	33	34	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59
60	61	62	63	64	65	66	67	68	69
70	71	72	73	74	75	76	77	78	79
80	81	82	83	84	85	86	87	88	89
90	91	92	93	94	95	96	97	98	99

## COOK'S CHERRY SHORTCAKES

*Cook's cherry shortcakes (for ten children)*  
250 g plain flour  
65 g butter  
25 g castor sugar  
150 ml milk  
2 eggs  
140 ml whipped cream  
500 g cherry pie filling

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250 g plain flour  
65 g butter  
25 g castor sugar  
150 ml milk  
2 eggs  
140 ml whipped cream  
500 g cherry pie filling

Colour:		
	in every	
	in every	
	in every	

Colour:		
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## ODDS AND EVENS

Odd	Even

Odd	Even



## SIMPLE BATTLESHIPS

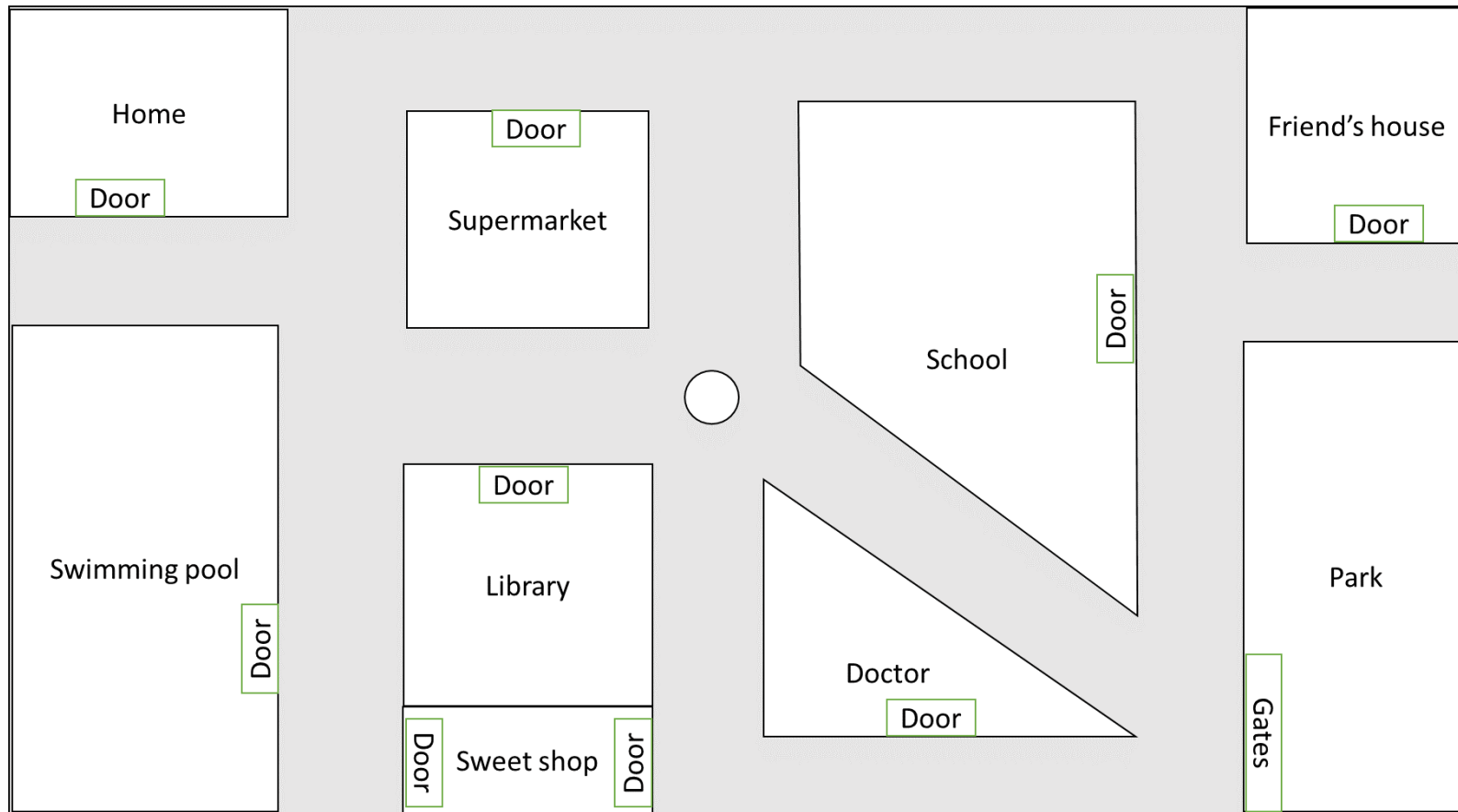
10										
9										
8										
7										
6										
5										
4										
3										
2										
1										
	A	B	C	D	E	F	G	H	I	J

List of squares I have fired at:

10										
9										
8										
7										
6										
5										
4										
3										
2										
1										
	A	B	C	D	E	F	G	H	I	J

List of squares I have fired at:

## ROBOTS



## SHAPE SORTER


# WORKSHEETS FOR LOWER PRIMARY

1-2

## TRAFFIC SURVEY

<i>Vehicle</i>	<i>Tally</i>	<i>Total</i>

<i>Vehicle</i>	<i>Tally</i>	<i>Total</i>