

PROBLEM-SOLVING EXAMPLES FOR DEVELOPING MASTERY IN UPPER PRIMARY

NATURE OF THE ACTIVITIES SUGGESTED HERE

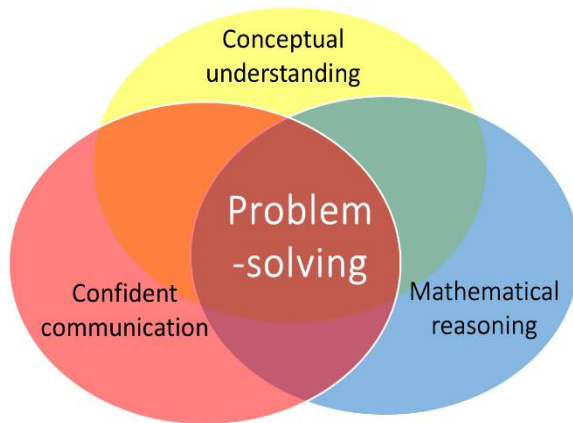
With the surge of interest and sometimes confused interpretations of what is meant by **mastery** in mathematics, different claims have been made about **mastery** and what is required. The efficacy of different aspects of mastery approaches to learning mathematics in the primary school, as demonstrated by higher performing jurisdictions in East Asia, as measured by PISA* and TIMSS* have been questioned and challenged.

However, there are some essential points which 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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5-6

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In some of the activities, one may argue 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.

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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<p>21. Concepts and Principles of Measurement</p> <p>To use and calculate with appropriate measures in real situations.</p> <p>Athletics is an aspect of P.E. where children can gain rich, practical, real-life experience of using measures, particularly in length and time. In these lessons, Year 5–6 children can take, and actually enjoy, the responsibility for measuring and recording their own and others' performance data and making comparisons between their previous and current attainments. It is also a cross-curricular application of mathematics in another part of the curriculum.</p>	<p>Sports maths In groups of 4–6, to measure and record measures. Each group will need access to:</p> <ul style="list-style-type: none">• Recording chart (see worksheets);• Stop-watches, metre stick/trundle wheel, long tape measure, as appropriate for the event. <p>In a typical primary athletics lesson, it is possible to include a carousel of events, such as sprints and other runs, long jump, high jump (standing or running jump depending on the school's facilities), skipping, distance throwing events (ball, bean bag, foam javelin, foam discus, etc.) In all of these there is the provision for recording times in seconds and possibly to the nearest tenth of a second, as well as distances in metres to two decimal places.</p> <p>For a particular event they can:</p> <ul style="list-style-type: none">• find the difference between their latest and previous distances, or times;• calculate the difference as a percentage change in the previous performance;• calculate their mean speed in metres/second over an event. <p>Typically these calculations may need the assistance of a calculator or spreadsheet, or times and distances may be suitably rounded to enable informal or written methods to be practised.</p> <p>Always encourage the children to focus on <i>ipsative</i> assessment: how they are improving their <i>present</i> performance compared to <i>their own</i> past performance, rather than comparing themselves against that of other children in their group or class. Top athletes focus primarily on how they can improve their <i>personal best</i>, rather than the difference between their performance and other people's.</p>	<p>Do the children use the different items of measuring equipment accurately, and interpret the scales and divisions correctly?</p> <p>Do they record the units they used to measure, not just the numbers?</p>
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Hundreds

Tens

Ones

DIVISION BY MULTIPLYING

The Nissota Car Manufacturer

Model of car	SuperExec	GazGuy	Missive	Yazz	Wego
Kilometres/litre	6	8	11	12	14

Division by Multiplying

The Nissota Car Manufacturer

Model of car	SuperExec	GazGuy	Missive	Yazz	Wego
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WORKSHEETS FOR UPPER PRIMARY

5-6

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

WORKSHEETS FOR UPPER PRIMARY

5-6

GO OFY WAYS TO MAKE 1!

$\frac{1}{2}$				
$\frac{1}{3}$				
$\frac{1}{4}$				
$\frac{1}{5}$				
$\frac{1}{6}$				
$\frac{1}{7}$				
$\frac{1}{8}$				
$\frac{1}{9}$				
$\frac{1}{10}$				

$\frac{1}{2}$				
$\frac{1}{3}$				
$\frac{1}{4}$				
$\frac{1}{5}$				
$\frac{1}{6}$				
$\frac{1}{7}$				
$\frac{1}{8}$				
$\frac{1}{9}$				
$\frac{1}{10}$				

CATALOGUE CHANGES

<u>Barry's Bikes Catalogue</u>		<u>Accessories page</u>	
A. LED light set	\$ 20.59	F. Bike helmet	\$ 14.57
B. Twin mudguards	\$ 16.21	G. 'D' lock	\$ 16.9
C. Tyre pump	\$ 8.34	H. Cycle computer	\$ 9.35
D. Rack	\$ 23.98	I. Basket	\$ 11.93
E. Gel cycle seat	\$ 25.89	J. Puncture repair kit	\$ 2.49

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SPORTS MATHS

<i>Team:</i>										
Event Name:										
Child's Name										

PAINTING WALL AREAS

Section of wall	Length (m)	Height (m)	Area of section (m ²)
Total area to be painted:			

Section of wall	Length (m)	Height (m)	Area of section (m ²)
Total area to be painted:			

HOW MANY DEGREES?

Shape	Angles	Sum of angles

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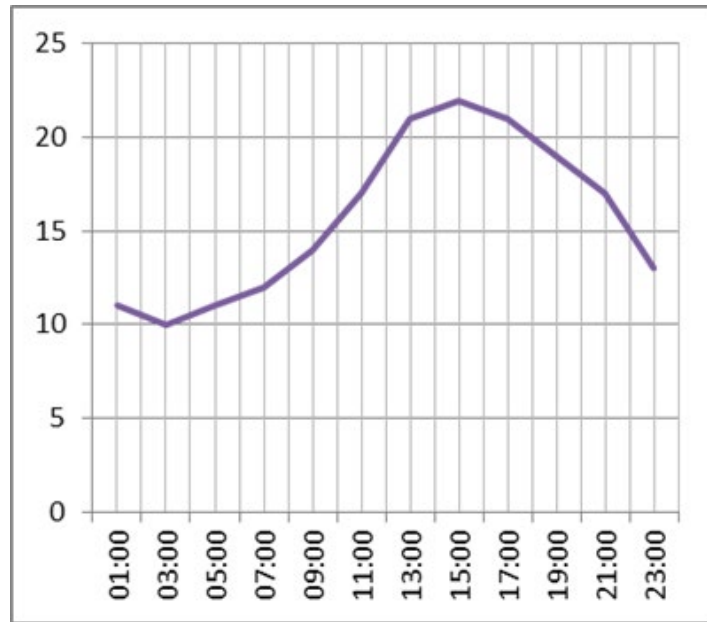
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<i>object</i>	<i>diameter (cm)</i>	<i>circum- ference (cm)</i>	<i>Possible relationship?</i>

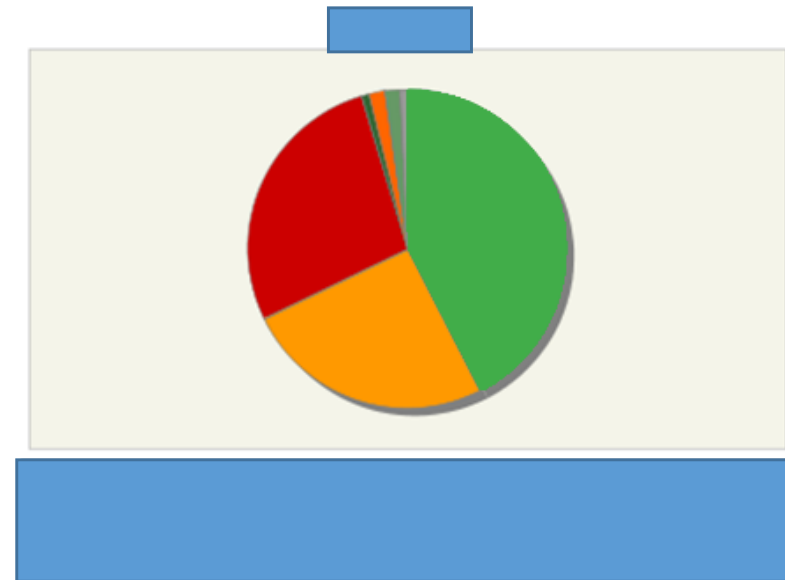
<i>object</i>	<i>diameter (cm)</i>	<i>circum- ference (cm)</i>	<i>Possible relationship?</i>

DATA DETECTIVES

A. Line Graph

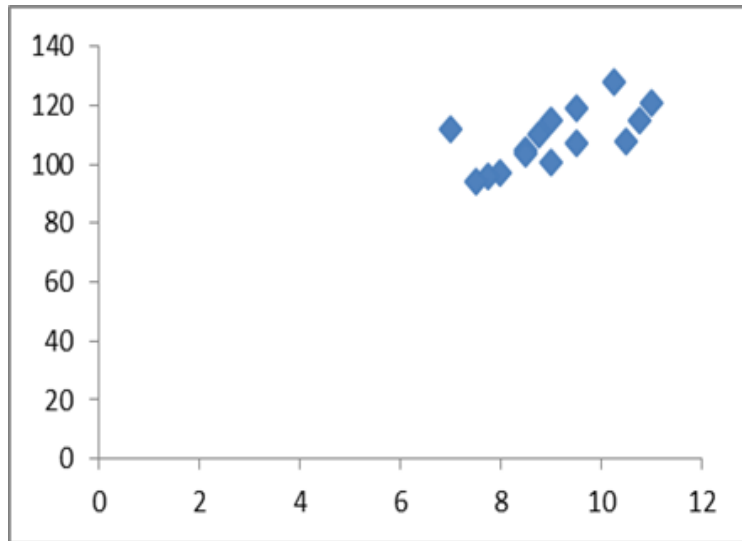


B. Pie Chart



DATA DETECTIVES

C. Scatter graph



D. Bar Chart

