Panaga School Calculation Policy

January 2020

Rationale

This policy outlines and models the progression of the written strategies used at Panaga School for addition, subtraction, multiplication and division. It has been developed in line with the 2014 National Curriculum of England which embeds a Concrete, Pictorial and Abstract (CPA) approach. Manipulatives (concrete apparatus) and pictorial representations that support the strategies taught are also represented. This model enables teachers to ensure consistency in the approaches children meet through the primary years. It allows children to progress stage by stage through models and representations they recognise from previous teaching. This enables the development of deeper conceptual understanding and fluency. Teachers will present strategies and equipment that is appropriate to children's level of understanding, supporting children to move forward at the pace appropriate to them. Each class will maintain a pace of learning at age appropriate levels with differentiation considerations as required.

The importance of mental mathematics
This policy focuses on written calculations in mathematics however it is important to recognise that mental strategies and known facts form the basis of all written calculations. The following outline some of the key skills and number facts that children are expected to develop throughout the school.

To add and subtract successfully, children should be able to:
- recall all addition pairs to 9 + 9 and number bonds to 10
- recognise addition and subtraction as inverse operations
- add mentally a series of one digit numbers (e.g. 5 + 8 + 4)
- add and subtract multiples of 10 or 100 using the related addition fact and their knowledge of place value (e.g. 600 + 700, 160 — 70)
- partition 2 and 3 digit numbers into multiples of 100, 10 and 1 in different ways (e.g. partition 74 into 70 + 4 or 60 + 14)
- use estimation by rounding to check answers are reasonable

To multiply and divide successfully, children should be able to:
- add and subtract accurately and efficiently
- recall multiplication facts to 12 x 12 = 144 and division facts to 144 ÷ 12 = 12
- use multiplication and division facts to estimate how many times one number divides into another etc.
- know the outcome of multiplying by 0 and by 1 and of dividing by 1
- understand the effect of multiplying and dividing whole numbers by 10, 100 and later 1000
- recognise factor pairs of numbers (e.g. that 15 = 3 x 5, or that 40 = 10 x 4) and increasingly able to recognise common factors

- derive other results from multiplication and division facts and multiplication and division by 10 or 100 (and later 1000)
- notice and recall with increasing fluency inverse facts
- partition numbers into 100s, 10s and 1s or multiple groupings
- understand how the principles of commutative, associative and distributive laws apply or do not apply to multiplication and division
- understand the effects of scaling by whole numbers and decimal numbers or fractions
- understand correspondence where n objects are related to m objects
- investigate and learn rules for divisibility

Doodle Maths

The school subscribes to Doodle Maths to support the development of mental maths skills for all students from P2- P7.

Doodle Maths adapts to meet children's current ability and knowledge. It facilitates frequent practice and also provides help and support to learners.

The app's mantra is "little and often". Children are prompted to complete a short selection of tasks each day. These cover various topics and, following a short assessment task, are chosen to keep children's knowledge fresh and to address weaknesses.

Parents and teachers can both be linked with each child's account allowing them to monitor and influence the progression through the app's challenges. Either a downloadable app or a web-based service is used to do so. In these, you can allocate extra exercises to children that concentrate on a specific maths topic. This mixes the best of both worlds: the constant tailoring to the individual's ability made by the app and a teacher's professional knowledge.
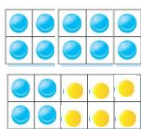
ADDITION

Step 1

Pupils use concrete objects and tens frames to explore number bonds to 10. Extend to crossing 10.

> 4 + 6 = 10
> 10 = 4 + 6
> 6 + 4 = 10
> 14 + 6 = 20

Step 2

Using number lines to count in ones.

$7 + 5 = \square$

Step 3

Written method, no regrouping.
Combine ones to find the total.

24 + 5 = 29

Step 4

Written method with regrouping.
Combine ones to find the total.

24 + 8 = 32
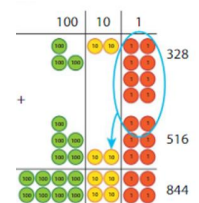
Step 5

Partitioning the single digit to bridge through 10.
Eg. 37 + 8   37 + ⑧ = 45

③ ⑤
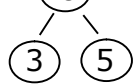
> 37 + 3 = 40
> 40 + 5 = 45

Step 6

Sequencing to add using a numberline.

+20   +8

35   55   63
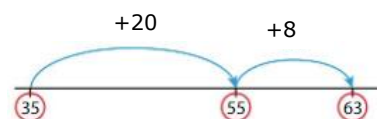
35+28
35+20=55
55+8=63

> Partition the smaller number
> 35 + 20 + 8 = 63

Step 7

Column addition, no regrouping.
32+26=

```
  32
+ 26
  50   add tens
   8   add ones
  58   add tens and ones
```

Step 8

Column addition with regrouping.
38+47

```
  38
+ 47
  70   add tens
  15   add ones
  85   add tens and ones
```

Step 9

Formal written method, no regrouping.

142 + 334
142 ≈ 140
334 ≈ 330

> Rounding to estimate

```
  1 4 2
+ 3 3 4
  4 7 6
```

> 2 + 4 = 6
> 40 + 30 = 70
> 100 + 300 = 400

Step 10

Formal written method with regrouping.

Estimate	H T O
328≈330	3 2 8
516≈520	5 1 6 +
850	8 4 4
	1

Step 11

Formal written method with decimals using place value first, no regrouping.

1.35+1.2

```
   1.35
+  1.20
   2.55
```
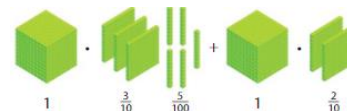
Step 12

Formal written method with regrouping.

```
TH  H T O . Ths
 5  2 5 6 . 9
 5  1 6 7 . 8
10  4 2 4 . 7
     1 1 1
```
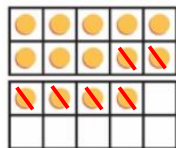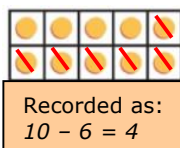
> Ths- 10 ths for 1
> Ones- 10 ones for 1 ten
> Tens- 10 tens for 1 hundred
> Add thousands

SUBTRACTION

Step 1
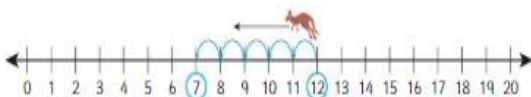Use concrete objects to subtract 1 digit numbers from numbers between 10 and 20. Progress to crossing 10.

Recorded as:
$14 - 6 = 8$

Recorded as:
$10 - 6 = 4$

Step 2
Using number lines to count back in ones.

$12 - 5 = \boxed{7}$

0 1 2 3 4 5 6 ⑦ 8 9 10 11 ⑫ 13 14 15 16 17 18 19 20

Step 3
Written method, no regrouping.
Subtract ones from a 2 digit number.

24   -   3   =   21

Step 4 and 5
Written method with regrouping.
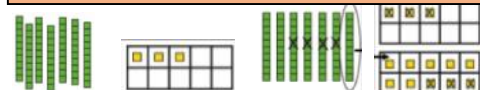Subtract a 1 digit number from a 2 digit number.

$35 - 8 =$

Regroup 1 ten from 35 to 10 ones, making 15 ones
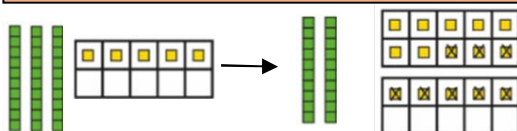
Progress to subtracting 2, 2 digit numbers.

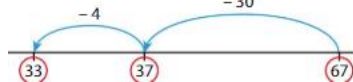$73 - 46 =$

Regroup 1 ten from 73 to 10 ones making 13 ones

Step 6
Sequencing to subtract.
Partition the smaller number.
$67 - 34$ is the same as: $67 - 30 - 4$

$67 - 30 = 37$
$37 - 4 = 33$

– 4   – 30
�33   ㊲   ㊻

Step 7
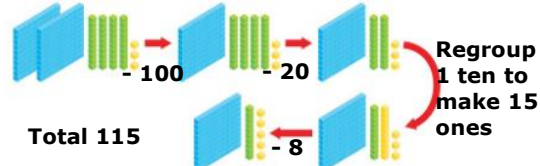Partitioning to subtract a 2 digit number from a 2 digit number.

$44 - 17 \longrightarrow$ $44 - 17 =$
                                      13   4
$44 - 4 = 40$ 10   3
$40 - 13 = 40 - 3 - 10$
$40 - 3 = 37$
$37 - 10 = 27$

Step 8
Subtracting a 3 digit number from a 3 digit number using base 10.
$243 - 128 = 115$

- 100   - 20   Regroup 1 ten to make 15 ones

Total 115   - 8

Step 9
Formal written method, no regrouping.

Estimate	H T O
355≈350	3 5 5
124≈120	1 2 4 −
230	2 3 0
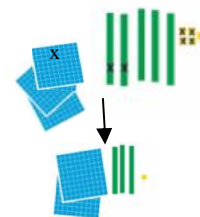
Step 10
Formal written method: expanded column method with regrouping.
$463 - 125$

$$400\ {}^560\ {}^13$$
$$-100\ \ 20\ \ \ 5$$
$$\underline{\ 300\ \ 30\ \ \ 8}$$

100	10	1

300   30   8

3 cannot subtract 5, regroup 1 ten to make 13
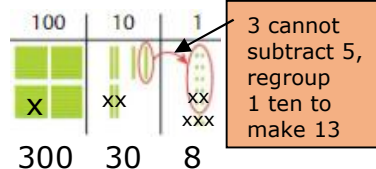
Step 11
Formal written method using decimals, confirming place value.

$$1.35$$
$$\underline{0.60}$$
$$0.75$$

1    $\frac{3}{10}$ $\frac{5}{100}$ $\frac{6}{10}$

Step 12
Extend steps 10 and 11 to numbers with any given number of digits and decimal numbers with 1 or 2 DP.

$$\begin{array}{r} {}^16\ {}^61 \\ 1374 \\ \underline{\ 968} \\ \ 406 \end{array}$$

$$\begin{array}{r} {}^2.\ {}^1 \\ 3.59 \\ \underline{1.68} \\ 1.91 \end{array}$$
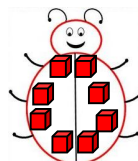
MULTIPLICATION

Step 1
Doubles, use concrete objects and pictorial representations.
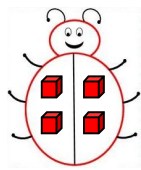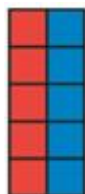
Might be recorded as:
$2 + 2 = 4$
$4 + 4 = 8$

Step 2
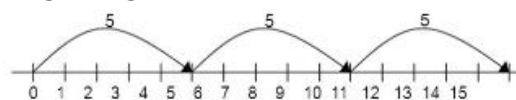Repeated addition and arrays 2, 5 and 10 times tables.

$2 + 2 + 2 + 2 + 2$

$5 \times 2 = 10$

Step 3
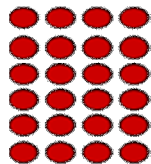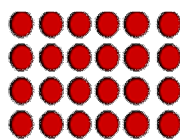Repeated addition along number lines.
$3 \times 5 = 15$

Progress step 2 and 3 to 6, 9 and 12 x tables.

Step 4
Arrays and commutativity using known facts to make new facts.

$4 \times 6 = 24$

$6 \times 4 = 24$

Step 5
Multiplying by 10, use place value sliders to model how numbers move left when multiplied by 10.
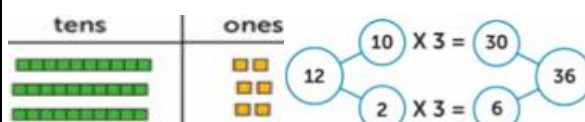5×10 H T U. ths hths
5
5 0
Progress to multiplying by 100, 1000.

Step 6
Regrouping using cherry model.
$12 \times 3 =$

tens	ones

$10 \times 3 = 30$
12
$2 \times 3 = 6$
36

Step 7
Array to grid method.
34×3
Model using concrete objects.

x	30	4
3	90	12

34
X3
12
90
102

Progress to multiplying 3 digit numbers by 1 and 2 digit numbers.

Step 8
Commutative law using factor pairs.
$18 \times 5 = 3 \times 6 \times 5$

3 x 6   3 x 6   3 x 6

3 x 6
3 x 6

It could also be $2 \times 9 \times 5$.

Step 9
Expanded multiplication progressing to short multiplication.

23   342
x6   progress to   x7
18 (6x3)   short multiplication   2394
120 (20x3)   2 1
138

Step 10
Long multiplication.
Th H T O
8136
x72
16272 (multiply by ones)
     1
569520 (multiply by tens)
     2 4
585792 (add the 2 products together)
 1

Step 11
Multiply one digit numbers with up to 2 decimal places, by whole numbers. Estimate answer first.
$3.71 \approx 4 \rightarrow 4 \times 8 = 32$ O ths hths
Answer less than 32.   3.71
                        x 8
                     29.68
                       5

Step 12
Progress steps 9, 10 and 11 to larger multi-digit numbers.

DIVISION

Step 1

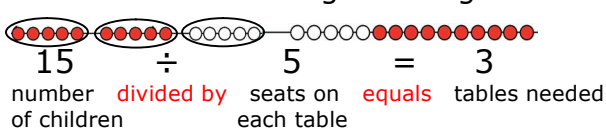Sharing - Use concrete objects and pictorial representations to share items equally into 2 groups.

Step 2

Grouping - 15 children at a picnic, a picnic table seats 5 children. How many tables do they need?
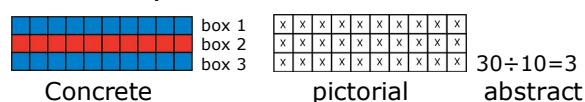
Model on a beadstring counting in 5s

15	÷	5	=	3
number of children	divided by	seats on each table	equals	tables needed

Step 3

Arrays - 16 flowers, planted in 4 rows. How many flowers in each row? Use arrays to show the answer.

$16 \div 4 = 4$

Step 4

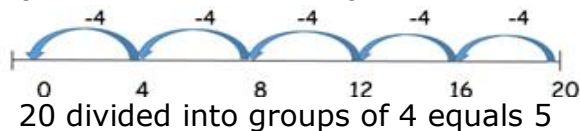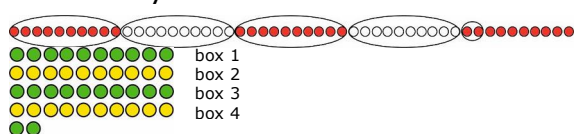CPA - Division by grouping using arrays. 30 eggs, 10 fit into each box. How many boxes are needed?

box 1
box 2
box 3

$30 \div 10 = 3$

Concrete   pictorial   abstract

Step 5

Repeated Subtraction
$20 \div 4 = 5$
$20 - 4 - 4 - 4 - 4 - 4 = 0$

20 divided into groups of 4 equals 5

Step 6

Steps 1, 2, 4 progress to division with remainders- 42 apples. 10 fit in a box. How many boxes?

box 1
box 2
box 3
box 4

$42 \div 10 = 3 \ r2$

Step 7

Sharing 2 digit numbers by ones with regrouping.
$55 \div 4 = 12 \ r \ 3$

Regroup 1 ten to 15 ones.
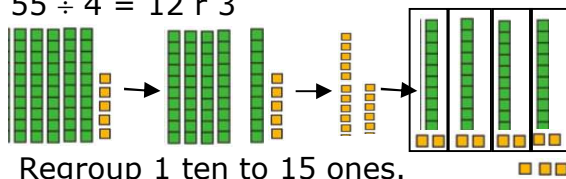
Step 8

Partitioning - Moving towards a formal written method.
$72 \div 3 = 24$
(60+12)

72 = 60 + 12

$60 \div 3 = 20 \quad 12 \div 3 = 4$
$20 + 4 = 24$
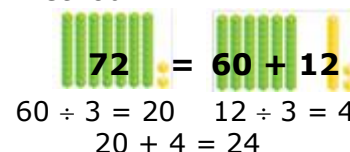
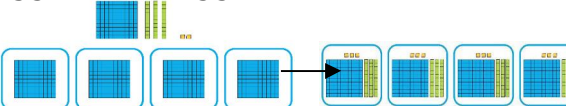## Step 9

Progress steps 7 and 8 to sharing multiple digits by ones with regrouping.
$532 \div 4 = 133$

Step 10

Division with remainders.
$1995 \div 9$
How many groups of 9 can you make?

Exchange thousand for hundreds.	2 groups of 9 hundreds, 1 left over. Exchange for tens.	2 groups of 9 tens. Exchange 1 left over for ones.	1 group of 9 ones, with 6 left. The answer is 221 R6
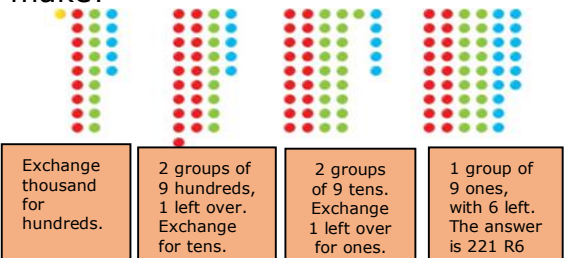
Model as a short division.

$9 \overline{)1^19^19^15}$ 2 2 1 R6

Step 11

Long division - Regrouping hundreds to tens.

$426 \div 3 = 142$

Progress to decimals and remainders.