



William Westley C of E Primary School

# Maths Calculation Policy

March 2015

Next review due: March 2016

## William Westley School Mathematics Calculation Policy

Mathematics is a creative and highly inter-connected discipline that has been developed over centuries, providing the solution to some of history's most intriguing problems. It is essential to everyday life, critical to science, technology and engineering, and necessary for financial literacy and most forms of employment. A high-quality mathematics education therefore provides a foundation for understanding the world, the ability to reason mathematically, an appreciation of the beauty and power of mathematics, and a sense of enjoyment and curiosity about the subject.

### Aims

The national curriculum for mathematics aims to ensure that all pupils:

- **Become fluent** in the fundamentals of mathematics, including through varied and frequent practice with increasingly complex problems over time, so that pupils develop conceptual understanding and the ability to recall and apply knowledge rapidly and accurately.
- **Reason mathematically** by following a line of enquiry, conjecturing relationships and generalisations, and developing an argument, justification or proof using mathematical language.
- **Solve problems** by applying their mathematics to a variety of routine and non-routine problems with increasing sophistication, including breaking down problems into a series of simpler steps and persevering in seeking solutions.

### Progression in Calculation

#### Key Skills

- Develop counting and the language of counting
- Develop understanding of the processes of counting and the number system
- Secure conceptual understanding of place value
- Use knowledge of known facts
- Develop confidence in mental calculation skills
- Understand operations and the relationships between them
- Foster mathematical thinking
- Develop skills in recording, including jottings

### Counting Development

- **Enactive** ~ actions, practical, real life context
- **Iconic** ~ representation, models, images, pictures
- **Symbolic** ~ recording, numbers, letters

## **Stages**

- Counting all
- Counting on from the first number
- Counting on from a larger number
- Using a known fact
- Using knowledge of place value

## **Preparing for Place Value**

**From Iconic to Symbolic:** Use concrete object, practical experiences and pictures to develop conceptual understanding of place value. Progression using models, images and pictures will secure symbolic understanding and secure knowledge of place value.

## **Towards Calculation**

- Confidence in mental calculation skills
- Conceptual understanding of place value is secure
- Practise and use the skill of estimation
- Understand the processes being used
- Compare and evaluate methods
- Develop a broad range of experiences in recording calculations ~ Can I do this in my head? Do I need a jotting? Do I need a written method?
- Foster mathematical thinking and discussion
- Make the maths real-link mathematics across the curriculum and to the outdoors.

**The following shows the progression in addition, subtraction, multiplication and division that each child will follow from Reception through to Year 6.**

# Progression in Addition

## Stage 1

Use concrete objects and pictorial representations to solve simple addition problems counting all. Introduce counting on using a number track putting the largest number first.

## Stage 2

Continue to use practical resources to *support* calculation. Introduce and *model* the use of the number-line. Children begin to use numbered lines to support their own calculations.

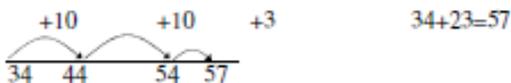
Bead strings or bead bars can be used to illustrate addition including bridging through ten by counting on 2 then counting on 3 when doing  $8+5$ .



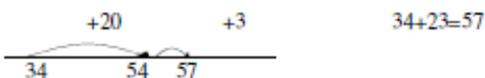
## Stage 3

Children will begin to use 'empty number lines' themselves starting with the larger number and counting on irrespective of the order of calculation.

**First counting on in tens and ones** then helping children to become more efficient by adding the units in one jump (e.g. by using the known fact  $4 + 3 = 7$ ).



**Followed by adding the tens in one jump and the units in one jump.**



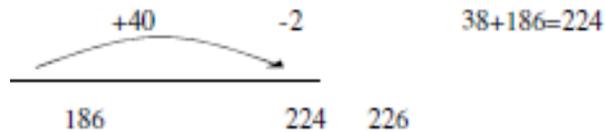
Children should use their understanding of addition to begin to add fractions with the same denominator.

$$\frac{2}{4} + \frac{2}{4} = \frac{4}{4}$$

## Stage 4

Children will continue to use empty number lines with increasingly large numbers, including compensation where appropriate.

### Compensation



**ALWAYS COUNT FORWARDS ON A NUMBER-LINE WHEN ADDING SO THE CHILDREN DO NOT GET CONFUSED.**

**COUNT ON = ADDITION**

Children will **begin** to use informal pencil and paper methods (jottings) to support, record and explain mental methods building on existing strategies.

**E.g. Partitioning** – record mental methods using partitioning.

$$47 + 76 = 76 + 40 + 7 = 116 + 7 = 123$$

Leading to:

$$70 + 6$$

$$\underline{40 + 7}$$

$$110 + 13 = 123$$

## Stage 5

Secure informal methods leading to the development of more formal written methods.

E.g. Partitioning by adding the most significant digits first, then moving to add the least significant first (Preparation for carrying)

$$\begin{array}{r} 67 \\ + 24 \\ \hline 11 \text{ (7 + 4)} \\ + 80 \text{ (60 + 20)} \\ \hline 91 \end{array}$$

$$\begin{array}{r} 267 \\ + 85 \\ \hline 12 \text{ (7+5)} \\ 140 \text{ (60 + 80)} \\ + 200 \text{ (200 + 0)} \\ \hline 352 \end{array}$$

From this, children will begin to carry below the line.

$$\begin{array}{r} 367 \\ + 85 \\ \hline 452 \\ 11 \end{array} \qquad \begin{array}{r} 2.84 \\ + 1.36 \\ \hline 4.20 \\ 11 \end{array}$$

*\*It is important to know that the decimal points should line up under each other, particularly when adding or subtracting mixed amounts, e.g. £3.59 + 78p.*

### **Stage 6**

Children should extend the carrying method to numbers with at least four digits, including decimals in a range of contexts e.g. money and measurement.

Children should use their understanding of addition to add fractions with the same denominator and fractions with denominators of the same number.

$$\begin{array}{r} \underline{2} \\ 5 \end{array} + \begin{array}{r} \underline{2} \\ 5 \end{array} = \begin{array}{r} \underline{4} \\ 5 \end{array}$$

### **Stage 7**

Children should extend the carrying method to numbers with any number of digits, including decimals and apply their understanding of addition and equivalent fractions to add fractions with different denominators and mixed numbers.

$$\begin{array}{r} \underline{2} \\ 5 \end{array} + \begin{array}{r} \underline{2} \\ 5 \end{array} = \begin{array}{r} \underline{4} \\ 5 \end{array} \qquad \begin{array}{r} \underline{2} \\ 3 \end{array} + \begin{array}{r} \underline{3} \\ 4 \end{array} = \begin{array}{r} \underline{8} \\ 12 \end{array} + \begin{array}{r} \underline{9} \\ 12 \end{array} = \begin{array}{r} \underline{17} \\ 12 \end{array} \text{ or } 1 \begin{array}{r} \underline{5} \\ 12 \end{array}$$

## **Progression in Subtraction**

### **Stage 1**

Use concrete objects and pictorial representations to solve simple subtraction problems, involving:-

- **'taking away'** finding how many are left when some are removed
- **'finding the difference'** by using practical objects/resources (e.g. beadstrings, cube towers or number tracks) to make a comparison between the numbers
- **'part/whole' situations** finding how many in a set fit a criteria e.g. 5 cars, 3 are red and the rest are blue. How many are blue?

## **Stage 2**

Continue to use practical resources to *support* calculation. Introduce and *model* the use of the number-line. Children begin to use numbered lines to support their own calculations.

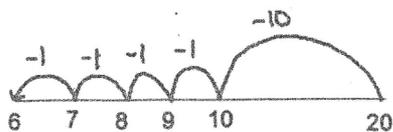
**ALWAYS COUNT BACK ON A NUMBER-LINE WHEN SUBTRACTING SO THE CHILDREN DO NOT GET CONFUSED.**

**COUNT BACK = SUBTRACTION**

### ➤ **Taking Away**

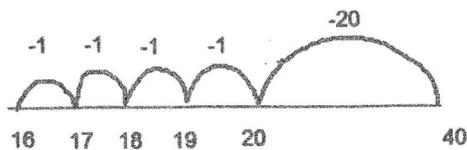
**1st) COUNTING BACK** in tens and ones.

$$20 - 14 = 6$$



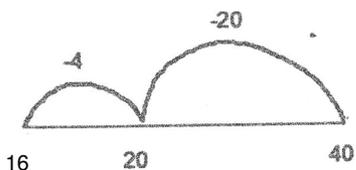
**2nd) COUNTING BACK** tens in one jump and units/ones in ones.

$$40 - 24 = 16$$



**3rd) COUNTING BACK** tens in one jump and units/ones in one jump.

$$40 - 24 = 16$$



## **Stage 3**

Children will continue to use structured number lines leading to empty number lines.

## **Stage 4**

Children will continue to use empty number lines with increasingly large numbers and will begin to use informal pencil and paper methods (jottings) to support, record and explain mental methods building on existing strategies.

### **Partitioning and decomposition**

*Initially, the children will be taught using examples that do not need the children to regroup.*

$$\begin{array}{r} 89 \\ -57 \\ \hline \end{array} = \begin{array}{r} 80 + 9 \\ 50 + 7 \\ \hline 30 + 2 \\ \hline \end{array} = 32$$

From this the children will begin to regroup.

$$\begin{array}{r} \phantom{0}^{60} \\ 70 + \phantom{0}^1 1 \\ - 40 + \phantom{0}^6 6 \\ \hline 20 + \phantom{0}^5 5 = 25 \end{array}$$

Children should demonstrate their place value knowledge lining units up under units, tens under tens, and so on.

They should continue to use an empty number line where the numbers are close together or near to multiples of 10, 100 etc to **count on**. A number-line can also be used for subtracting decimals.

### **Stage 5**

Children should be secure in a method for subtraction. Some children may continue confidently working in subtraction on a number line.

### **Partitioning and decomposition**

$$\begin{array}{r} \phantom{0}^{600} \phantom{0}^{140} \\ 700 + 50 + \phantom{0}^1 4 \\ - \phantom{0}^{80} + \phantom{0}^6 6 \\ \hline \phantom{0}^{600} + \phantom{0}^{60} + \phantom{0}^8 8 = 668 \end{array}$$

### **Decomposition**

$$\begin{array}{r} \phantom{0}^{14} \\ 6754 \\ - \phantom{0}^{86} \\ \hline 668 \end{array} \qquad \begin{array}{r} \phantom{0}^{14} \\ 565.3 \\ - \phantom{0}^{8.7} \\ \hline 56.6 \end{array}$$

### **Stage 6**

Children should extend the decomposition method to numbers with any number of digits, including decimals in a range of contexts including money and measurement. Number lines and mental methods should also be used, if more efficient than decomposition.

Children should use their understanding of subtraction to subtract fractions with the same denominator and fractions with denominators of the same number.

$$\frac{4}{5} - \frac{2}{5} = \frac{2}{5}$$

*\*It is important to know that the decimal points should line up under each other, particularly when adding or subtracting mixed amounts, e.g. £3.59 - 78p.*

## Stage 7

Children should extend the re-grouping method to numbers with any number of digits, including decimals and apply their understanding of subtraction and equivalent fractions to subtract fractions with different denominators and mixed numbers.

$$\frac{2}{3} - \frac{1}{2} = \frac{4}{6} - \frac{3}{6} = \frac{1}{6}$$

## Progression in Multiplication

### Stage 1

Children will use concrete objects, pictorial representations and arrays in context, with the support of the teacher, to work on practical problem solving activities involving equal sets or groups. They will begin to make connections between different representations and to count in twos, fives and tens and extend to other patterns.

### Stage 2

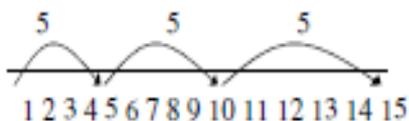
Children will begin to develop their recording using pictures and written descriptions and continue to use a wide range of representations including repeated addition, commutativity, arrays and scaling.

#### ➤ Repeated addition

3 times 5 is  $5 + 5 + 5 = 15$  or 3 lots of 5 or  $5 \times 3$

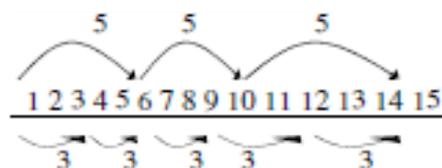
Repeated addition can be shown easily on a number line:

$$5 \times 3 = 5 + 5 + 5$$



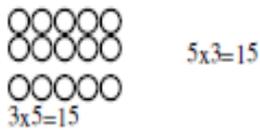
#### ➤ Commutativity

Children should know that  $3 \times 5$  has the same answer as  $5 \times 3$ . This can also be shown on the number line.



➤ **Arrays**

Children should be able to model a multiplication calculation using an array.



➤ **Scaling**

Children will develop an understanding of scaling and comparative language e.g. twice as high, half as long, linked to doubling and halving.

**Stage 3**

Using every day practical experiences and resources, children will develop an understanding of **multiplicative reasoning** (multiplying, not counting) including through:

- Positive Integer **Scaling** e.g. Find a ribbon that is 4 times as long as the blue ribbon.



Use language of scaling e.g. four times as high, eight times as long.

Correspondence problems in which **m** objects are connected to **n** objects e.g. 3 hats and 4 coats, how many different outfits?

➤ **Associativity**

$$(2 \times 3) \times 4 = 2 \times (3 \times 4) = 24 \text{ or } 6 \times 15 = 6 \times (5 \times 3) = (6 \times 5) \times 3 = 30 \times 3 = 90$$

➤ **Partitioning**

$$\begin{aligned} 38 \times 5 &= (30 \times 5) + (8 \times 5) \\ &= 150 + 40 \\ &= 190 \end{aligned}$$

➤ **Using known multiplication facts**

$19 \times 4 =$	$10 \times 4 = 40$	$24 \times 3 =$	$10 \times 3 = 30$
	$9 \times 4 = 36$		$10 \times 3 = 30$
	$40 + 36 = 76$		$4 \times 3 = 12$
			$30 + 30 + 12 = 72$

Extend to 3-digit number multiplied by a single digit.

### **Stage 4**

Multiply a 2-digit number by a single digit.

$$17 \times 4 =$$

$$\begin{array}{r} 10 \quad 7 \\ X \quad 4 \\ \hline 28 \quad (4 \times 7) \\ 40 \quad (4 \times 10) \\ \hline 68 \quad (28 + 40) \\ \hline \end{array}$$

Extend to a 3-digit number multiplied by a single digit.

### **Stage 5**

Multiply 2, 3 and 4 digit numbers by a single digit.

$$\begin{array}{r} 24 \\ X \quad 6 \\ \hline 24 \quad (6 \times 4) \\ + 12 \quad (6 \times 2) \\ \hline 36 \quad (24 + 12) \\ \hline \end{array} \qquad \begin{array}{r} 342 \\ x \quad 7 \\ \hline 14 \quad (7 \times 2) \\ 280 \quad (7 \times 40) \\ + 2100 \quad (7 \times 300) \\ \hline 2394 \\ \hline \end{array}$$

$$\begin{array}{r} 2741 \\ X \quad 6 \\ \hline 6 \quad (6 \times 1) \\ 240 \quad (6 \times 40) \\ 4200 \quad (6 \times 700) \\ 12000 \quad (6 \times 2000) \\ \hline 16446 \\ \hline \end{array}$$

## **Stage 6**

Multiply 2 and 3-digit number by a 2-digit number.

$$\begin{array}{r} 24 \\ \times 16 \\ \hline \end{array}$$

$$\begin{array}{r} 24 \text{ (6 x 4)} \\ 120 \text{ (6 x 20)} \\ 40 \text{ (10 x 4)} \\ + 200 \text{ (10 x 20)} \\ \hline 384 \end{array}$$

$$\begin{array}{r} 124 \\ \times 26 \\ \hline \end{array}$$

$$\begin{array}{r} 24 \text{ (6 x 4)} \\ 120 \text{ (6 x 20)} \\ 600 \text{ (6 x 100)} \\ 80 \text{ (20 x 4)} \\ 400 \text{ (20 x 20)} \\ + 2000 \text{ (20 x 100)} \\ \hline 3224 \\ \hline 11 \end{array}$$

## **Stage 7**

Multiply 2, 3 and 4-digit numbers by a single digit using short multiplication.

$$\begin{array}{r} 24 \\ \times 6 \\ \hline \end{array}$$

$$\begin{array}{r} 144 \\ \hline 2 \end{array}$$

$$\begin{array}{r} 342 \\ \times 7 \\ \hline \end{array}$$

$$\begin{array}{r} 2394 \\ \hline 21 \end{array}$$

$$\begin{array}{r} 2741 \\ \times 6 \\ \hline \end{array}$$

$$\begin{array}{r} 16446 \\ \hline 42 \end{array}$$

Extend to multiplying a 2 and 3-digit number by a 2-digit number.

$$\begin{array}{r} 2 \\ 24 \\ \times 16 \\ \hline \end{array}$$

$$\begin{array}{r} 144 \\ + 240 \\ \hline 384 \end{array}$$

$$\begin{array}{r} 12 \\ 124 \\ \times 26 \\ \hline \end{array}$$

$$\begin{array}{r} 744 \\ + 2480 \\ \hline 3224 \\ \hline 11 \end{array}$$

## **Stage 8**

Children should apply their knowledge and understanding of multiplication and use materials and diagrams to multiply proper fractions and mixed numbers by whole numbers e.g.  $\frac{2}{3} \times 3$  or  $2\frac{1}{2} \times 3$ .

## **Stage 9**

Apply understanding in the use of formal written methods for short and long multiplication and to multiply pairs of proper fractions.

## Progression in Division

### Stage 1

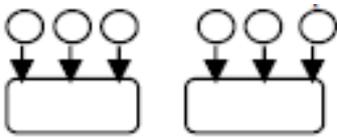
Children will use concrete objects, pictorial representations and arrays in context, with the support of the teacher, to work on practical problem solving activities involving equal sets or groups. Children will begin to find simple fractions of objects, numbers and quantities.

### Stage 2

Children will begin to develop their recording using pictures and written descriptions and continue to use a wide range of representations including:

➤ **Sharing equally:**

6 sweets shared between 2 people, how many do they each get?

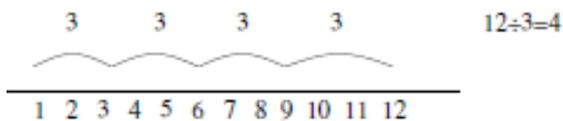


➤ **Grouping or arrays:**

There are 6 sweets. How many people can have 2 sweets each?



➤ **Counting on or back using a number line or bead bar:**

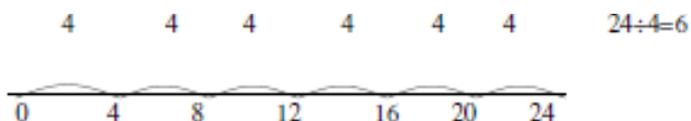


Link fractions to division and find simple fractions ( $\frac{1}{3}$ ,  $\frac{1}{4}$ ,  $\frac{1}{2}$ ,  $\frac{3}{4}$ ) of a length, shape, set of objects or quantity.

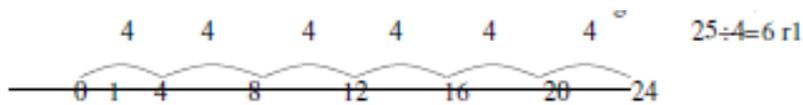
### Stage 3

#### **Use arrays and link to counting on or back using a number line**

Children will use an empty number line to support their calculation.

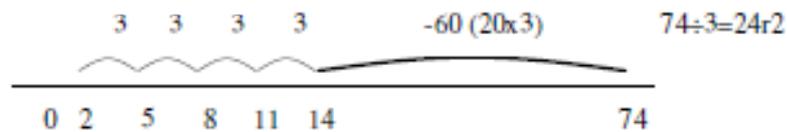


Children should also move onto calculations involving remainders.



### Stage 4

Children will develop their use of the reverse array method and number line to add or subtract multiples of the divisor for calculations with or without a remainder.



### Stage 5

Children to use the chunking method to divide a 2, 3 or 4 digit number by a single digit with and without remainders.

$$\begin{array}{r}
 14 \\
 7 \overline{) 98} \\
 \underline{70} \text{ (x10)} \\
 28 \\
 \underline{28} \text{ (x4)} \\
 0
 \end{array}$$

$$\begin{array}{r}
 86 \text{ r}2 \\
 5 \overline{) 432} \\
 \underline{400} \text{ (x 80)} \\
 32 \\
 \underline{30} \text{ (x 6)} \\
 2
 \end{array}$$

Any remainders should be shown as integers, i.e. 14 remainder 2 or 14 r 2.

Children need to be able to decide what to do after division and round up or down accordingly.

For example  $62 \div 8$  is 7 remainder 6, but whether the answer should be rounded up to 8 or rounded down to 7 depends on the context.

### Stage 6

Children will move to using short division for numbers up to THU  $\div$  U, interpreting remainders for the context.

$$\begin{array}{r}
 14 \\
 7 \overline{) 98}
 \end{array}$$

$$\begin{array}{r}
 86 \text{ r}2 \\
 5 \overline{) 432}
 \end{array}$$

### **Stage 7**

Children will use chunking (Stage 5) as the formal written method to divide numbers up to 4 digits by a 2 digit number.

Any remainders should be shown as fractions, i.e. if the children were dividing 32 by 10, the answer should be shown as  $3 \frac{2}{10}$  which could then be written as  $3 \frac{1}{5}$  in its lowest terms.

They should also apply their knowledge and understanding of division and use materials and diagrams to divide proper fractions by whole numbers.

E.g.  $\frac{1}{2} \div 2 = \frac{1}{4}$