## Brough Primary School



\section*{Calculation Policy (Multiplication and division) <br> | Policy Date | February 2022 |
| :---: | :---: |
| Policy Review Date | February 2024 |
| Lead Person | Mrs. Wilson |}

This policy has been largely adapted from the White Rose Maths Hub Calculation Policy ( $\mathbf{2 0 2 0}$ version) and EYFS framework ( 2021 version) with further material added. It is a working document and will be revised and amended as necessary.

## Rationale of Calculation policy

- Lays out the expectations for both mental and written calculations for addition and subtraction and has been created to support the teaching of a mastery approach to mathematics.
- Underpinned by the use of of the different models and representations that can be used to support the teaching of different concept.
- Based on the idea that mathematical understanding is developed through use of representations that are first of all concrete (e.g. counters and multilink cubes), and then pictorial (e.g part whole) to then facilitate abstract working (e.g. formal written methods).
- Each operation is broken down into skills. Each of the skills has dedicated pages showing the different models and representatives that could be used to effectively teach that concept.
- A glossary of terms is also at the end of the calculation policy to support understanding of the key language used to teach the addition and subtraction. This should also be read in conjunction with the vocabulary document.

An overview of the different models and images used to support the teaching of multiplication and division at Brough Primary School.

- Bar models.
- Numicon.
- Bead strings.
- Number tracks.

- Number lines.
- Base 10.
- Place value counters.



## Time tables - overview of skills in different year groups.

| 7 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 2 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 |
| 3 | 3 | 6 | 9 | 12 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 |
| 4 | 4 | 8 | 12 | 16 | 20 | 24 | 28 | 32 | 36 | 40 | 44 | 48 |
| 5 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 |
| 6 | 6 | 12 | 18 | 24 | 30 | 36 | 42 | 48 | 54 | 60 | 66 | 72 |
| 7 | 7 | 14 | 21 | 28 | 35 | 42 | 49 | 56 | 63 | 70 | 77 | 84 |
| 8 | 8 | 16 | 24 | 32 | 40 | 48 | 56 | 64 | 72 | 80 | 88 | 96 |
| 9 | 9 | 18 | 27 | 36 | 45 | 54 | 63 | 72 | 81 | 90 | 99 | 108 |
| 10 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 |
| 11 | 11 | 22 | 33 | 44 | 55 | 66 | 77 | 88 | 99 | 110 | 121 | 132 |
| 12 | 12 | 24 | 36 | 48 | 60 | 72 | 84 | 96 | 108 | 120 | 132 | 144 |




Time tables - overview of skills in different year groups.

| Year | skills | How - <br> representations and <br> models | Additional guidance |
| :---: | :---: | :---: | :---: |

Time tables - overview of skills in different year groups.

| Year | skills | How representations and models | Additional guidance |
| :---: | :---: | :---: | :---: |
| 2 | Recall and use multiplication and division facts for 5 -times table <br> $\mathrm{N}_{3} \mathrm{~N}_{3} \mathrm{~N}_{3}$ <br>  <br> 0000000000 | As previous. <br>  <br> $000-00000$ | Encourage daily counting in multiples, both forwards and backwards. <br> Look for patterns in five times table using concrete manipulatives to support. <br> Notice the pattern in the ones as well as highlighting the odd, even, odd, even pattern. |

Time tables - overview of skills in different year groups.

| Year | skills | How representations and models | Additional guidance |
| :---: | :---: | :---: | :---: |
| 2 | Recall and use multiplication and division facts for 10 -times table | As previous | Encourage daily counting in multiples, both forwards and backwards. <br> Look for patterns in tens times table using concrete manipulatives to support. <br> Notice the pattern in the digits - the ones are always 0 and the tens increase by 1 ten each time. |

## Time tables - overview of skills in different year groups.

| Year | skills | How - <br> representations and <br> models | Additional guidance |
| :--- | :--- | :--- | :--- | :--- | :--- |

## Time tables - overview of skills in different year groups.



Time tables - overview of skills in different year groups.

| Year | skills |  |  |  |  |  | How - representations and models |  |  |  |  | Additional guidance |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 3 | Recall and use multiplication and division facts for 8 times table |  |  |  |  |  |  | Hundred square, bead strings, number tracks, everyday objects, Numicon. |  |  |  | Encourage daily counting in multiples, both forwards and |
| 8888888888888888 |  |  |  |  |  | 13 | 4 5 <br> 14 15 <br> 15  | 5 <br> 15 <br> 15 <br> 18 | $\left\lvert\, \begin{array}{l\|l\|} \hline 17 \\ 17 \end{array}\right.$ | ${ }_{19}{ }^{19}$ |  | Look for patterns in |
|  |  |  |  |  | 22 | 23 | (2) 25 | 2526 | ${ }_{27} 28$ | 29 |  | eight times table |
| $\overbrace{8}^{*}$ |  |  |  |  | (2) | 33 | 34.35 | 3536 | 37.38 | 39 | (6) | using manipulatives |
|  |  |  |  |  | 42 | 43 | 44.45 | 4546 | 47 (1) | 49 | 50 | to support. |
|  |  |  |  |  | 52 | 53 | 50.55 | 55 -3 | 5758 | 59 | 60 | Make links to the 4 |
|  |  |  |  |  |  | ${ }^{63}$ | 74.65 | 55 66 <br> 75 76 | ${ }^{67} 788$ | 79 | $\bigcirc$ | time table, see how |
|  |  |  |  |  | 82 | 33 | 8485 | 858 | 8788 | 89 |  | each multiple is |
|  | 16 | 24 | 32 | 40 | 92 | 93 | 9495 | 2596 | 97138 | 99 | 100 | double the four. |
|  | 56 | 64 | 72 | 80 |  |  |  |  |  |  |  | Notice the pattern in |
| $00000000-00000000-00000000-$$\risingdotseq$ 1 1 1 1 1 1 1 1 1 1 1 1 <br>  8 16 24 32 40 48 56 64 72 80 88 96 |  |  |  |  |  |  |  |  |  |  |  | the ones within each group of five multiples. <br> Highlight that all multiples are even using Numicon to support. |



## Time tables - overview of skills in different year groups.



Time tables - overview of skills in different year groups.


Time tables - overview of skills in different year groups.



# Multiplication - overview of skills in different year groups 



## Multiplication - overview of skills in different year groups.

| Year | White Rose scheme <br> of learning | Skills- ELG | Skills- EYFS framework |
| :---: | :---: | :---: | :---: |
| EYFS | Find my pattern | Explore and represent <br> patterns within numbers up <br> to 10, including evens and <br> odds, double facts and how <br> quantities can be distributed <br> equally. | Multiplication and Division <br> I use grouping and sharing <br> in play and practical <br> contexts (e.g giving out <br> grapes at snack time.) |

Multiplication - overview of skills in different year groups.

| Year | skills | How - re and | Additional guidance |
| :---: | :---: | :---: | :---: |
| 1 and 2 | Solve one-step problems with multiplication. <br> - exel-xex-0000 <br> One bag holds 5 apples. How many apples do 4 bags hold? | Bar mo counte bead st Do000- $\stackrel{Y}{100}$ | Represent <br> multiplication as repeated addition in many different ways. <br> Y1 - use concrete and pictorial representations. Not expected to record multiplication formally. Y2- introduce to the multiplication symbol. |

Multiplication - overview of skills in different year groups.

| Year | skills | How - representations and models | Additional guidance |
| :---: | :---: | :---: | :---: |
| 3 and 4 | Multiply 2-digit by 1-digit numbers | Place value counters, Base 10, short written method. | Place value counters used to support understanding of the method rather than the multiplication. |
| 4 | Multiply 3-digit by 1-digit numbers | As above | Base 10 and place value counters continue to support the understanding of the written method. <br> Limit the number of exchanges and move children away from resources when multiplying larger numbers. |

## Multiplication - overview of skills in different year groups.



Multiplication - overview of skills in different year groups.
$\left.\begin{array}{|c|c|c|c|}\hline \text { Year } & \text { skills } & \begin{array}{c}\text { How - representations } \\ \text { and models }\end{array} & \text { Additional guidance } \\ \hline \mathbf{5} & \text { Multiply 2 digit by 2 digit numbers } & \begin{array}{c}\text { As previous plus area } \\ \text { and grid method. }\end{array} & \begin{array}{c}\text { Look at grid method as } \\ \text { an initial written method } \\ \text { before moving onto } \\ \text { formal written }\end{array} \\ \text { multiplication method. }\end{array}\right]$

## Multiplication - overview of skills in different year groups.



## Division- overview of skills in different year groups



## Division - overview of skills in different year groups.

| Year | skills | How - representations <br> and models | Additional guidance |
| :---: | :---: | :---: | :---: |
| $\mathbf{1}$ and 2 | Solve one-step problems with <br> division (sharing) | Bar model, real life <br> objects, arrays, <br> counters. | Y1- use concrete and <br> pictorial <br> representations. Not <br> expected to record <br> division formally. <br> Y2 - introduce to the <br> division symbol. |
| $\mathbf{1}$ and 2 | Solve one-step problems with <br> division (grouping) | As above plus <br> Numicon, bead strings, <br> ten frames, number <br> lines. | Grouping encourages <br> the link to repeated <br> subtraction on a <br> number line. |

Division - overview of skills in different year groups.


Division - overview of skills in different year groups.

| Year | skills | How - representations and models | Additional guidance |
| :---: | :---: | :---: | :---: |
| 3 and 4 | Divide 2-digits by 1 digit (sharing with exchange) | As previous | Use Base 10 and place value counters to exchange one ten for ten ones. <br> Flexible partitioning in a part-whole model support this method. |
| 3 and 4 | Divide 2-digits by 1 digit (sharing with remainders) | Base 10, bar model, place value counters, part-whole model. | As above. |
|  |  |  |  |

$\left.\begin{array}{|c|c|c|c|}\hline \text { Year } & \text { skills } & \begin{array}{c}\text { How - representations } \\ \text { and models }\end{array} & \text { Additional guidance } \\ \hline \mathbf{4} \text { and 5 } & \text { Divide 2-digits by 1 digit (grouping) } & \begin{array}{c}\text { Place value counters, } \\ \text { place value grid, written } \\ \text { short division. }\end{array} & \begin{array}{c}\text { Language is important } \\ \text { here e.g How many } \\ \text { groups of 4 ones can } \\ \text { we make? }\end{array} \\ \hline \mathbf{4} & \text { Divide 3-digits by 1 digit (sharing } \\ \text { with exchange) }\end{array} \quad \begin{array}{c}\text { Base 10, bar model, } \\ \text { place value counters, } \\ \text { part-whole model. }\end{array} \quad \begin{array}{c}\text { Continue to use place } \\ \text { value counters to share } \\ \text { into equal groups. }\end{array}\right\}$

| Year | skills | How - representations <br> and models | Additional guidance |
| :---: | :---: | :---: | :---: |
| $\mathbf{5}$ | Divide 4-digits by 1 digit (grouping) | Place value counters, <br> place value grid, written <br> short division. | Should be encouraged <br> to move away from <br> concrete and pictorial <br> when dividing numbers <br> with multiple <br> exchanges. |
| $\mathbf{6}$ | Divide multi-digits by 2-digit (short <br> division) | Written short division, <br> list of multiples. | Can write out multiples <br> to support their <br> calculations. |
| $\mathbf{6}$ | Divide multi-digits by 2-digit (long <br> division) | As above | As above for multiples. <br> Can leave as a |
|  |  |  | remainder or convert it <br> into a fraction - <br> depends on context of <br> question. |

The benefit of each of the different models and representatives used to teach multiplication and division at Brough Primary School.


## Bar Model



|  |  | ? |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| 3 | 3 | 3 | 3 | 3 | 3 | 3 |

$$
\begin{aligned}
& 3 \times 7=21 \\
& 7 \times 3=21
\end{aligned}
$$



$$
21 \div 7=3
$$



Girls

## Benefits

Children can use the single bar model to represent multiplication as repeated addition. They could use counters, cubes or dots within the bar model to support calculation before moving on to placing digits into the bar model to represent the multiplication.

Division can be represented by showing the total of the bar model and then dividing the bar model into equal groups.

It is important when solving word problems that the bar model represents the problem.

Sometimes, children may look at scaling problems. In this case, more than one bar model is useful to represent this type of problem, eg. There are 3 girls in a group. There are 5 times more boys than girls. How many boys are there?
The multiple bar model provides an opportunity to compare the groups.

## Number Shapes



## Benefits

Number shapes support children's understanding of multiplication as repeated addition.

Children can build multiplications in a row using the number shapes. When using odd numbers, encourage children to interlock the shapes so there are no gaps in the row. They can then use the tens number shapes along with other necessaryshapes over the top of the row to check the total. Using the number shapes in multiplication can support children in discovering patterns of multiplication e.g. odd $\times$ odd $=$ even, odd $\times$ even $=$ odd, even $\times$ even $=$ even.

When dividing, number shapes support children's understanding of division as grouping. Children make the number they are dividing and then place the number shape they are dividing by over the top of the number to find how many groups of the number there are altogether e.g. There are 6 groups of 3 in 18 .

## Bead Strings

## $-\infty-\infty-\infty-\infty 00-00-$

$$
\begin{aligned}
& 5 \times 3=15 \\
& 3 \times 5=15
\end{aligned}
$$

-D000-00000-00000-

$$
\begin{aligned}
& 5 \times 3=15 \\
& 3 \times 5=15
\end{aligned}
$$

$15 \div 5=3$
-0000-000-0000-0000-0000-

## Benefits

Bead strings to 100 can support children in their understanding of multiplication as repeated addition. Children can build the multiplication using the beads. The colour of beads supports children in seeing how many groups of 10 they have, to calculate the total more efficiently.
Encourage children to count in multiples as they build the number e.g. 4, 8, 12, 16, 20.

Children can also use the bead string to count forwards and backwards in multiples, moving the beads as they count.

When dividing, children build the number they are dividing and then group the beads into the number they are dividing by e.g. 20 divided by 4 - Make 20 and then group the beads into groups of four. Count how many groups you have made to find the answer.

## Number Tracks


$6 \times 3=18$
$3 \times 6=18$


$$
18 \div 3=6
$$

## Benefits

Number tracks are useful to support children to count in multiples, forwards and backwards. Moving counters or cubes along the number track can support children to keep track of their counting. Translucent counters help children to see the number they have landed on whilst counting.

When multiplying, children place their counter on O to start and then count on to find the product of the numbers.
When dividing, children place their counter on the number they are dividing and the count back in jumps of the number they are dividing by until they reach 0 . Children record how many jumps they have made to find the answer to the division.

Number tracks can be useful with smaller multiples but when reaching larger numbers they can become less efficient.

## Number Lines (labelled)



$$
\begin{aligned}
& 4 \times 5=20 \\
& 5 \times 4=20
\end{aligned}
$$



$$
20 \div 4=5
$$

## Benefits

Labelled number lines are useful to support children to count in multiples, forwards and backwards as well as calculating single-digit multiplications.

When multiplying, childrenstart at O and then count on to find the product of the numbers.
When dividing.start at the number they are dividing and the count back in jumps of the number they are dividing by until they reach 0 .
Children record how many jumps they have made to find the answer to the division.

Labelled number lines can be useful with smaller multiples, however they become inefficient as numbers become larger due to the required size of the number line.

## Number Lines (blank)

 A red car 4 times less.
How far does the red car travel?

## Benefits

Children can use blank number lines to represent scaling as multiplication or division.

Blank number lines with intervals can support children to represent scaling accurately. Children can label intervals with multiples to calculate scaling problems.

Blank number lines without intervals can also be used for children to represent scaling.

## Base 10/Dienes (multiplication)

| Hundreds | Tens | Ones |
| :---: | :---: | :---: |
|  | 11 | **** |
|  | 11 | $\cdots . .0$ |
|  |  | $\cdots$ * * |



## Benefits

Using Base 10 or Dienes is an effective way to support children's understanding of column multiplication. It is important that children write out their calculation alongside the equipment so they can see how the concrete and written representations match.

As numbers become larger in multiplication or the amounts of groups becomes higher, Base 10 / Dienes becomes less efficient due to the amount of equipment and number of exchanges needed.

Base 10 also supports the area model of multiplication well. Children use the equipment to build the number in a rectangular shape which they then find the area of by calculating the total value of the pieces This area model can be linked to the grid method or the formal column method of multiplying 2 -digits by 2 -digits.

## Base 10/Dienes (division)


$68 \div 2=34$

| Tens | Ones |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| 1 | - | - | - | * |
| 1 | * | * | * | * |
| 1 | - | - | - | * |

## Benefits

Using Base 10 or Dienes is an effective way to support children's understanding of division.

When numbers become larger, it can be an effective way to move children from representing numbers as ones towards representing them as tens and ones in order to divide. Children can then share the Base 10/ Dienes between different groups e.g. by drawing circles or by rows on a place value grid.

When they are sharing, children start with the larger place value and work from left to right. If there are any left in a column, they exchange e.g. one ten for ten ones. When recording, encourage children to use the partwhole model so they can consider how the number has been partitioned in order to divide. This will support them with mental methods.

## Place Value Counters (multiplication)



## Benefits

Using place value counters is an effective way to support children's understanding of column multiplication. It is important that children write out their calculation alongside the equipment so they can see how the concrete and written match.

As numbers become larger in multiplication or the amounts of groups becomes higher, Base 10 / Dienes becomes less efficient due to the amount of equipment and number of exchanges needed The counters should be used to support the understanding of the written method rather than support the arithmetic.

Place value counters also support the area model of multiplication well. Children can see how to multiply 2 digit numbers by 2 -digit numbers.

## Place Value Counters (division)



## Benefits

Using place value counters is an effective way to support children's understanding of division.

When working with smaller numbers, children can use place value counters to share between groups. They start by sharing the larger place value column and work from left to right. If there are any counters left over once they have been shared, they exchange the counter e.g. exchange one ten for ten ones. This method can be linked to the part-whole model to support children to show their thinking.

Place value counters also support children's understanding of short division by grouping the counters rather than sharing them. Children work from left to right through the place value columns and group the counters in the number they are dividing by. If there are any counters left over after they have been grouped, they exchange the counter eg, exchange one hundred for ten tens.

## Glossary

Array - An ordered collection of counters, cubes or other item in rows and columns.

Commutative - Numbers can be multiplied in any order.

Dividend - In division, the number that is divided.

Divisor - In division, the number by which another is divided.

Exchange - Change a number or expression for another of an equal value.

Factor - A number that multiplies with another to make a product.

Multiplicand - In multiplication, a number to be multiplied by another.

Partitioning - Splitting a number into its component parts.

Product - The result of multiplying one number by another.

Quotient - The result of a division
Remainder - The amount left over after a division when the divisor is not a factor of the dividend.

Scaling - Enlarging or reducing a number by a given amount, called the scale factor

