

Roseberry Primary and Nursery School



Maths Calculation Policy

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Written by: E. Gray, March 2023

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This policy will outline the progression in calculation in the four operations of mathematics that is used at Roseberry Primary school. It will demonstrate the core representations that we will use to teach and develop the understanding of each operation throughout school. It is not an exhaustive list, and staff will certainly use other representations to show variation in independent practice once a secure foundation has been built.

1. Concrete resources

Early number sense:

Understanding of number begins in Early Years. Staff use a variety of real-life and abstract representations to build children's familiarity with number sense. This includes use of rekenreks, five frames, Numberblocks and dice frames seen in the NCETM Mastering Number programme. Children will become familiar with numbers to 5, including subitising. They will develop their skills in counting, including cardinality and 1:1 correspondence. They will begin to rote count with larger numbers and think about the relative sizes of numbers to 10, including finding 1 more and 1 less.

Addition:

- within 10 and 20 – multilink and part whole, rekenrek, tens frames
- within 100 – base 10
- within 1000 – base 10
- beyond 1000 – PV counters

Subtraction:

- within 10 and 20 – multilink and part whole, rekenrek, tens frames
- within 100 – base 10
- within 1000 – base 10
- beyond 1000 – PV counters

Multiplication:

- numbers within known tables – arrays, making 'lots of' and 'groups of'
- numbers within 100 – PV counters, base 10
- numbers within 1000 – PV counters, base 10
- numbers beyond 1000 – PV counters

Division:

- numbers within known tables – sharing and grouping in circles
- numbers within 100 – PV counters, base 10
- numbers within 1000 – PV counters, base 10
- numbers beyond 1000 – PV counters

Examples of what this might look like are attached to this policy (Appendix 1).

2. Pictorial and abstract representations

Once a concrete resource has been used, children may feel confident using a more abstract representation in order to work more efficiently. Sometimes, teachers may choose to use the abstract representation first, or move on to it very quickly, particularly when dealing with larger numbers where using concrete resources might be more confusing. This is at the teacher's discretion based on the needs of the children.

Abstract representations progress from diagrams and pictorial representations through to the use of mathematical symbols, notation and number only.

These may include, but are not limited to, those listed below:

- Drawings of contextual problems, e.g. children with plates of food
- Part whole models
- Bar models
- Number lines
- Drawn versions of concrete resources
- Jottings including mental calculations
- Grid methods

3. Formal written methods

Addition and subtraction:

From Year 2, it is expected that children begin to use the formal columnar methods of addition and subtraction with 2-digit numbers.

	2	1
+	1	1
<hr/>		

	2	8
+	1	3
<hr/>		

	2	5
-	1	3
<hr/>		

	4	4
-	2	7
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When exchanging 10 ones for 1 ten in addition, the extra ten should be placed underneath the bottom horizontal line of the equals sign in the tens column.

In subtraction, when an exchange is required from the tens to the ones column, the tens digit should be crossed out, one subtracted and the new tens digit written above it in the tens column. A small 1 should be written in front of the ones digit.

The same methods should be applied and extended to larger numbers.

Multiplication:

From Year 3, it is expected that children begin to use the formal method of short multiplication.

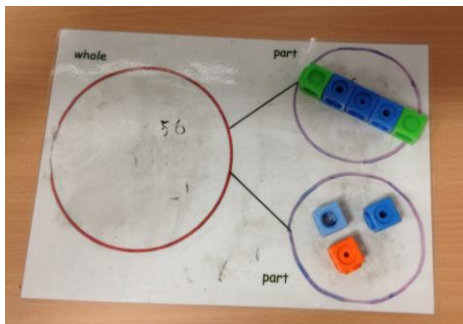
	8	6
×		6
5	1	6
	3	

When an exchange is required, from (for example) the ones to the tens column, the tens digit should be written underneath the equals sign, as in addition and subtraction.

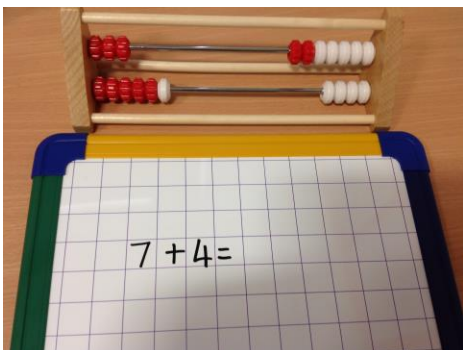
From Year 5, it is expected that children will encounter the written method for long multiplication. Colour-coding may be used to help children remember the process. When an exchange is required, the carried digit should be placed above the calculation so that it does not get confused for a carried digit in the addition part of the method.

<p>①</p> $\begin{array}{r} 321 \\ \times 23 \\ \hline \end{array}$	<p>②</p> $\begin{array}{r} 321 \\ \times 23 \\ \hline 3 \end{array}$	<p>③</p> $\begin{array}{r} 321 \\ \times 23 \\ \hline 63 \end{array}$	<p>④</p> $\begin{array}{r} 321 \\ \times 23 \\ \hline 963 \end{array}$
<p>⑤</p> $\begin{array}{r} 321 \\ \times 23 \\ \hline 963 \\ 0 \end{array}$	<p>⑥</p> $\begin{array}{r} 321 \\ \times 23 \\ \hline 963 \\ 20 \end{array}$	<p>⑦</p> $\begin{array}{r} 321 \\ \times 23 \\ \hline 963 \\ 420 \end{array}$	<p>⑧</p> $\begin{array}{r} 321 \\ \times 23 \\ \hline 963 \\ 6420 \end{array}$
<p>⑨</p> $\begin{array}{r} 321 \\ \times 23 \\ \hline 963 \\ + 6420 \\ \hline 7383 \end{array}$			

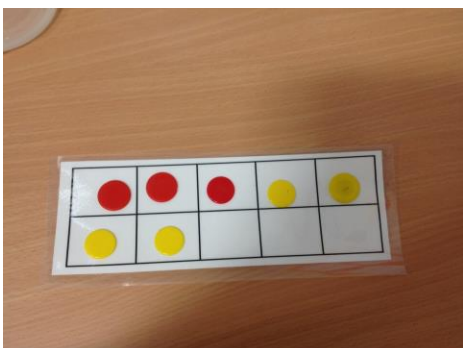
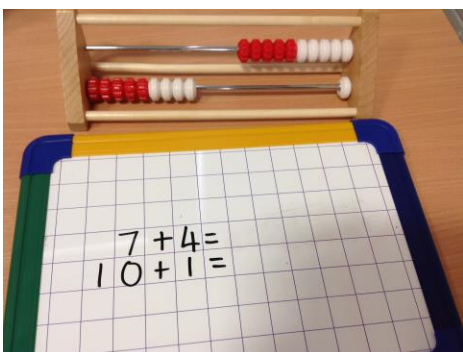
Appendix 1: Addition within 10 and 20



Using part whole models is a good way to develop stem sentences related to addition. E.g. 5 is a part, 3 is a part, 8 is a whole. The use of multilink means that children can still rely on 1:1 correspondence and touch counting if needed.

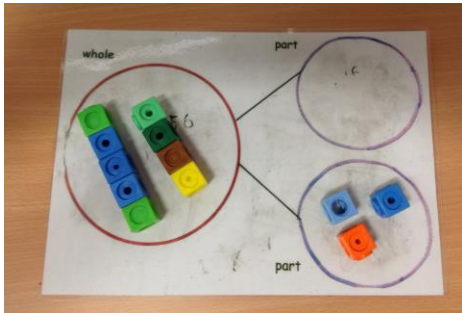


The two stages of the calculation using rekenrek is shown. Rekenrek is useful for calculations where children need to bridge ten. They can adjust the calculation to one that they find easier to do mentally. This strategy could be followed by more abstract methods such as using a number line by adding to ten first, or by partitioning an addend into two parts (e.g. in the example shown, 4 would be partitioned into 3 and 1, because $7+3=10$).

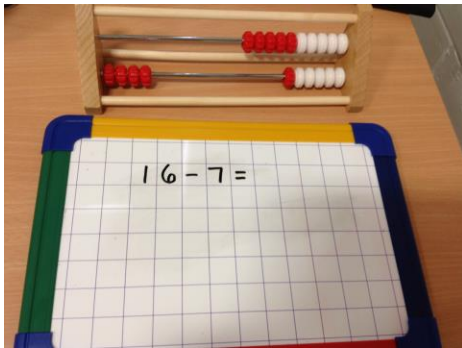


Tens frames are useful for children who still rely on touch counting, but can aid them with subitising so that they can count on rather than always start from 1. In the example shown, children should recognise that one whole side of the tens frame is full, so there are 5 and 2 more.

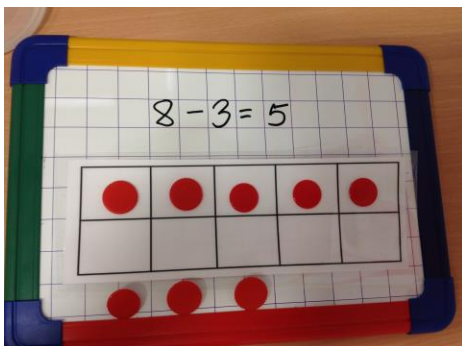
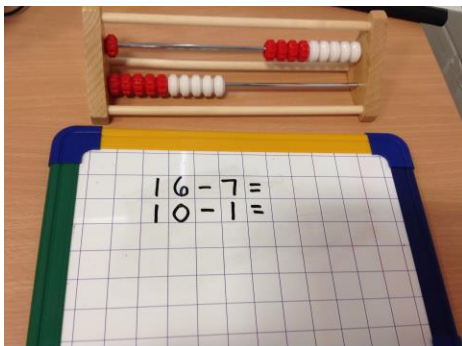
Subtraction within 10 and 20



Using part whole models is a good way to develop stem sentences related to subtraction. E.g. 9 is the whole and 3 is a part. Although the picture shows the part and whole both present with multilink, we would first expect to see the minuend as the whole and then the subtrahend moved to the part to give the 'left over' difference to move to the other part. The image in the photograph would be a linking step between using manipulatives and a more abstract part whole model where the numbers are written as digits.

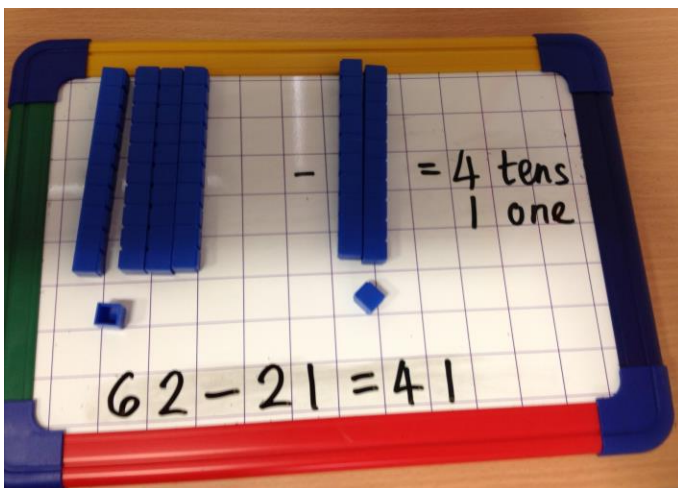
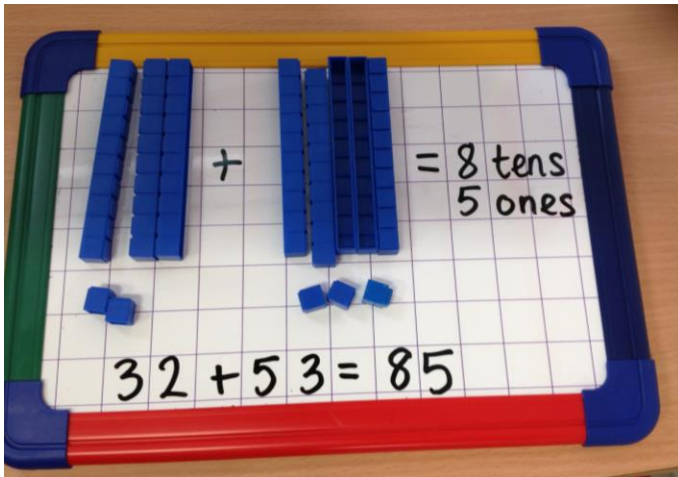


The two stages of the calculation using rekenrek is shown. Children can immediately remove the '6' from the bottom row of the rekenrek, and then see that only one more needs to be subtracted from the ten on the top row. This would link closely to moving to using number lines for subtraction and/or partitioning of a number to aid in mental subtraction.



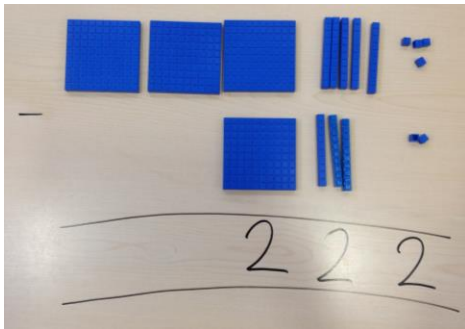
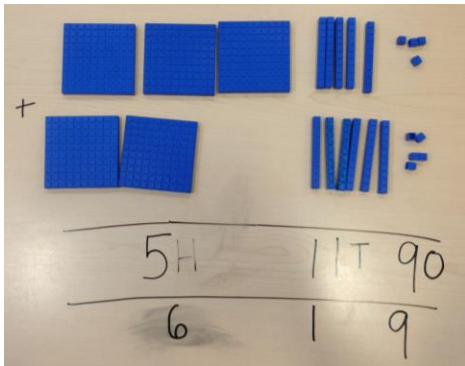
Tens frames allow children to physically remove the subtrahend to see the difference. They provide a chance to use subitising and solidify known facts within ten by providing a visual aid. It is important that children have a good number sense up to 10 before moving on to larger numbers.

Addition and subtraction within 100



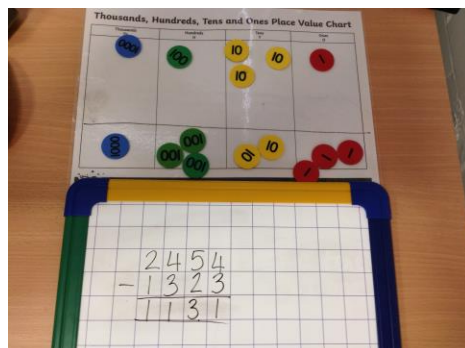
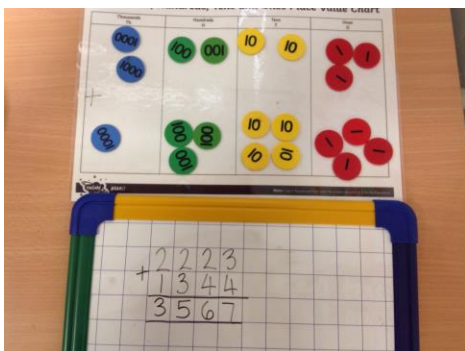
Base 10 is a useful tool for adding and subtracting within 100. Although the examples shown in the photographs do not require exchanges, base 10 equipment is a great visual aid to support children's understanding of exchanging 1 ten for 10 ones. It has been chosen above the use of place value counters as the relative sizes of the ones and tens helps children to understand the equivalence. The use of base 10 can be linked to the formal written methods of addition and subtraction by arranging the numbers above and below each other in columns rather than side by side. Base 10 can also be used alongside representations such as part whole models, bar models and number lines. Children should begin to solidify their understanding that they should add or subtract the ones then then tens in case they need to exchange.

Addition and subtraction within 1000



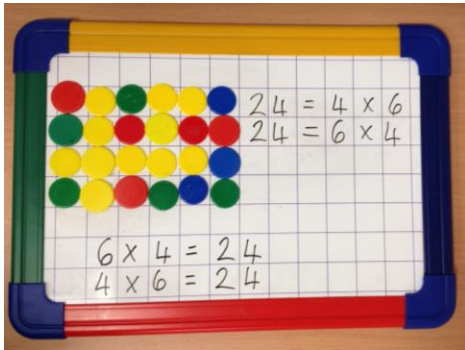
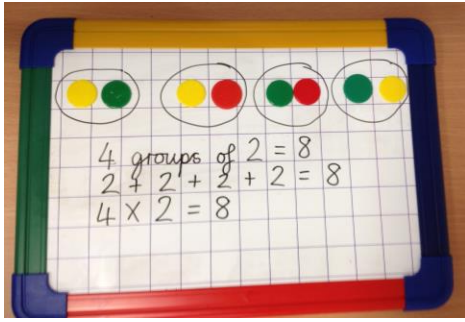
Here, base 10 is shown linking more clearly to the formal columnar methods of addition and subtraction. Although the image of subtraction shows both the minuend and subtrahend represented with base 10, as with the part whole representation of subtraction, in practice this may look different. Students may only make the minuend, remove the subtrahend, and be left with the difference. It is important that by this stage children are confident in their understanding that they should start with the ones column and move sequentially through each place value column moving to the left. Again, base 10 is chosen above place value counters as the initial manipulative to use due to the relative size of the equipment. Some children may move on quickly to more abstract representations, others may have a less developed understanding of place value and may prefer to use base 10 for longer.

Addition and subtraction beyond 1000



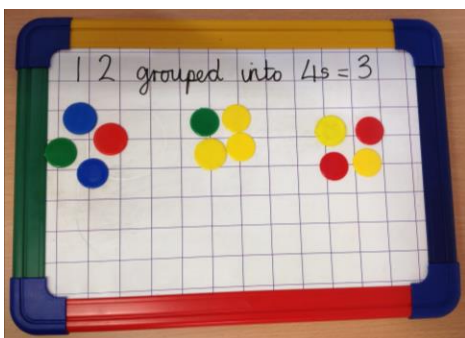
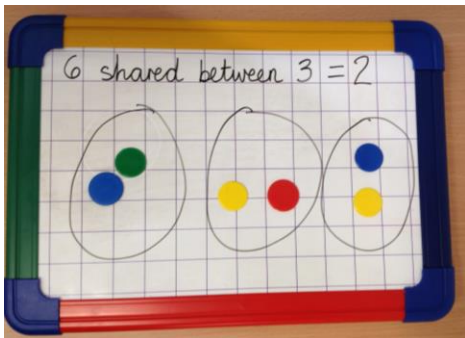
By the time children are working with numbers beyond 1000, they are likely to have a solid understanding of place value. It is for this reason, and for practicality in terms of space on desks, that we recommend the use of place value counters above the use of base 10 at this point. The use of place value counters alongside a place value grid and the now familiar formal written methods, allows children to apply prior learning to larger numbers with support. This is an important step to reinforce the procedural knowledge that children have about the written methods without assuming understanding that (for example) 10 hundreds is the same as 1 thousand.

Multiplying within known tables



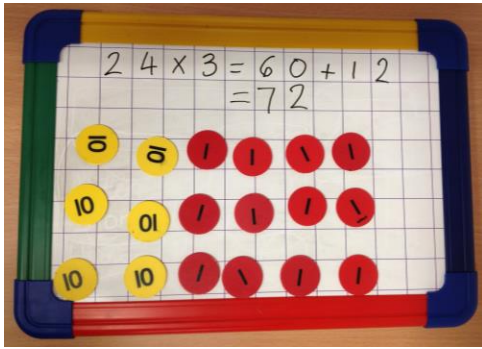
Counters are used in the images here, but any object can be substituted into this method, particularly when making groups or sharing. For example, a teacher may choose to contextualise a problem and give pencils to children, or put equal amounts of fruit on multiple plates to help children understand the concept of equal groupings. Arrays are a useful way of showing equal groups and are easily drawn once children are familiar with them. Both of the methods shown here link well with repeated addition and commutativity.

Dividing within known tables

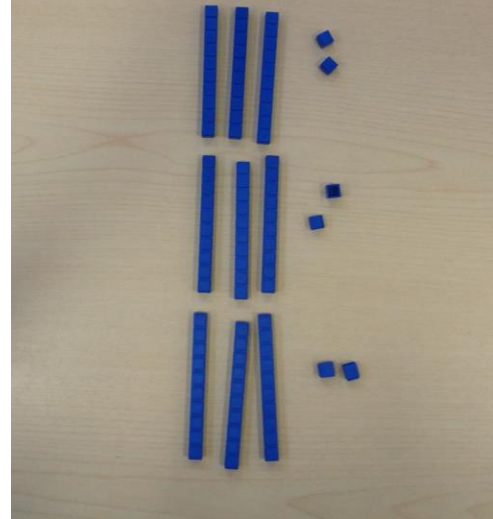


Again, the use of counters may be preceded by the use of more contextual objects to help children to understand the underlying structure of sharing and grouping. The language of sharing and grouping can be used before the division symbol (\div) is introduced. At this stage, children should hopefully begin to make links between known multiplication facts and division. In KS1 this may rely heavily on skip counting, by the end of LKS2 more children should have automatic recall of these facts.

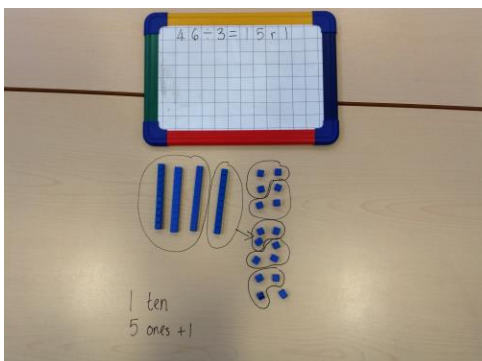
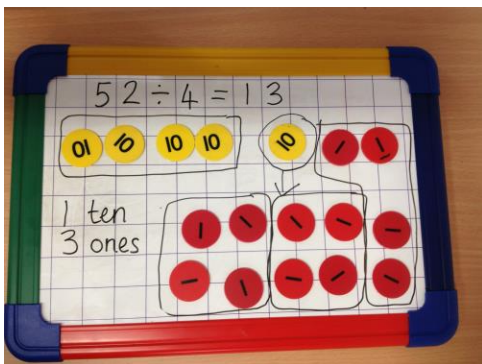
Multiplying within 100



Both base 10 and place value counters are equally valid ways to support the teaching of multiplying within 100. Some teachers and students prefer to use base 10 to aid with exchanges, especially if children are not yet comfortable that 10 ones is the same as 1 ten. Both strategies allow children to effectively partition the calculation into tens and ones, which is a useful precursor to the formal written method. They reiterate previous learning that multiplication is repeated equal groups.

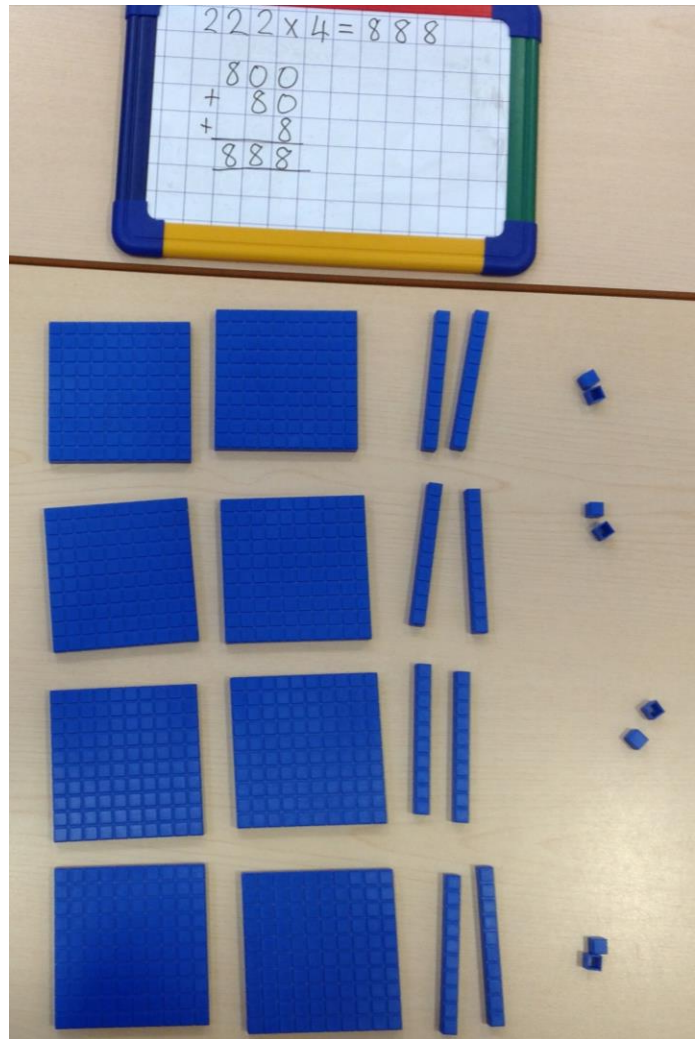
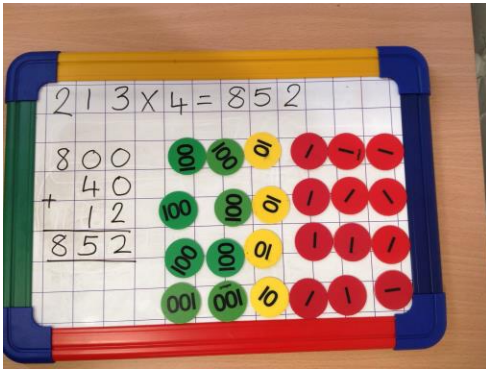


Dividing within 100



Again, both place value counters and base 10 equipment can be used in a similar way to represent grouping by the divisor. By starting with the tens, exchanging if necessary, then grouping the ones, children are beginning to develop the prerequisite learning for formal, efficient written methods. From using manipulatives, children will begin to replace them with their own drawings or jottings as a way of becoming more efficient before being taught formal methods. The use of manipulatives aids children who may not yet have automatic recall of their times tables.

Multiplying within 1000

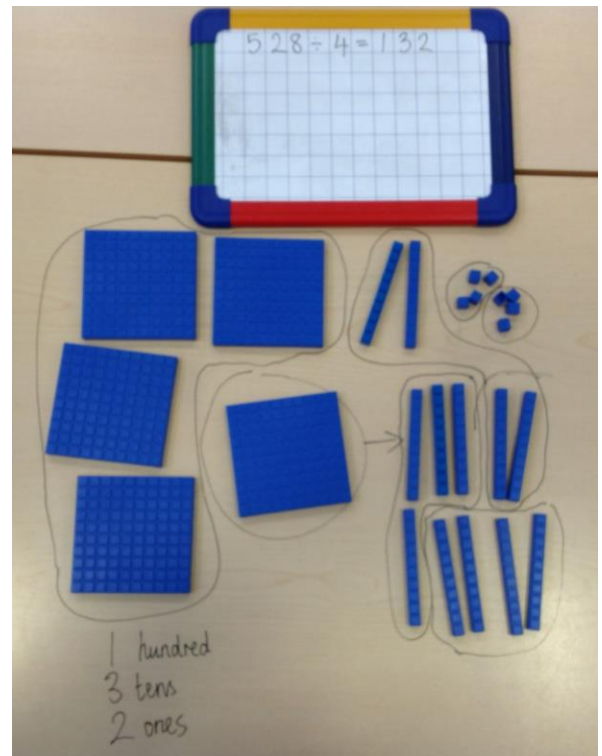


Base 10 and place value counters are both reasonable resources to use for multiplication within 1000. They again allow children to see the repeated structure of multiplication when applied to larger numbers.

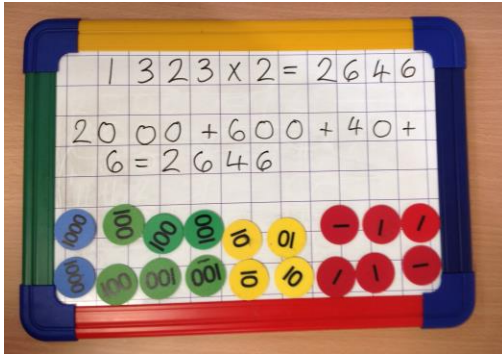
Dividing within 1000



Base 10 and place value counters again provide a similar foundation for learning about division. Both allow children to physically exchange 1 ten for 10 ones, and 1 hundred for 10 tens. In practice, children would remove the exchanged hundred or ten so as not to confuse themselves, they are shown in the photographs for demonstration only.



Multiplying and dividing beyond 1000



By the time numbers beyond 1000 are used, place value counters are preferable to base 10 as they are much more practical in terms of the space that is required on desks. The same structures can be used as with smaller numbers, and these all link to more abstract representations and formal written methods.