New approach to teaching times tables at Sheet Primary School

September 2022

How do we currently teach times tables?

Key Stage 1

- We do not expect our Year 2 children to enter Year 3 with **specific times table recall.**

- What they do arrive in Key Stage 2 with is:
- The ability to count in steps of groups of numbers eg: 2, 4, 6, 8 linked to their 2, 5, 10 and 3 times tables.
- a deep understanding of the commutativity of multiplication
- of multiplication as repeated addition, using manipulatives and pictures to calculate products. E.g. 7 x 5 as 7 groups of 5 sweets.

- We have made a conscious decision to not teach nor expect multiplication recall in Year 2 however some children will have secured some knowledge in their times tables when arriving in Year 3.

How do we currently teach times tables?

Key Stage 2

- The teaching of times tables becomes more explicit as children move into Herons with them working through times tables facts from each times table in a specific order. Teaching continues as appropriate, and moves into deepening security of facts, as they move into upper key stage 2.
- Our current times tables approach allows children to work at their own level; they work on securing their times table facts for all times tables up to 12x12 before revising them again, learning the associated division facts
- eg 12 x 3 = 36 → 36 ÷ 12 + 3

What are some of the challenges?

The downsides that we have identified from teaching in this way over a few years:

- Because everyone is working at different levels, it is harder to offer tailored support and really identify the barrier to a child making progress within a particular times table.
- Division facts are not learnt alongside multiplication facts meaning manipulation and application of facts as they progress through their school years may be less secure.
- Recall of facts is not as deep and secure as we would hope – we still see children counting up in steps to arrive at the answer, rather than being able to recall the fact immediately.

What's our rationale for change?

- We don't want maths to be all about rote learning facts to recall
- We don't want maths to be all about 'passing' tests
- We do want all our children to love maths and succeed within the maths curriculum.
- We see (and it is well-known) that children who can recall facts, enjoy maths and are able to secure the maths curriculum more effectively that those who struggle to recall these facts.
- Multiplication number facts are the building blocks of so many other areas of maths –
- eg if I don't know 7 x 3 then I won't know 37 x 30, 17 x 3, 21 ÷ 3
- And the main reason…

There are not many facts to learn!

- There are 36 key building block facts to learn up to 9 x 9
- Securing these 36 facts is of prime importance within Herons Class (year 3/4) as this enables children to approach the concepts of formal short multiplication and division calculations securely.
- There are roughly 39 weeks in a school year, equating to essentially one new fact a week.
- It is achievable for most children to learn these facts and make fabulous progress!
- During the latter part of year 4, additional attention is given to x10, x11 and x12 to support the children in the end of year Government Multiplication Test Check.

What does the new way look like?

- Times table fluency is taught **separately** from application of these facts.
- We cover **teaching of relationships** and **deriving facts** separately to times table fluency although the relationships of multiplicative commutativity (3x7 = 7x3) and linked relationships to division (7x3= 21 21÷3 =7) are reinforced in our new approach.
- We, of course, explicitly link to multiplication facts when deriving facts, such as 30 x 70, but within a place value context (in this case). "We know seven threes are _____ so we know…"
-

So, how does it work?

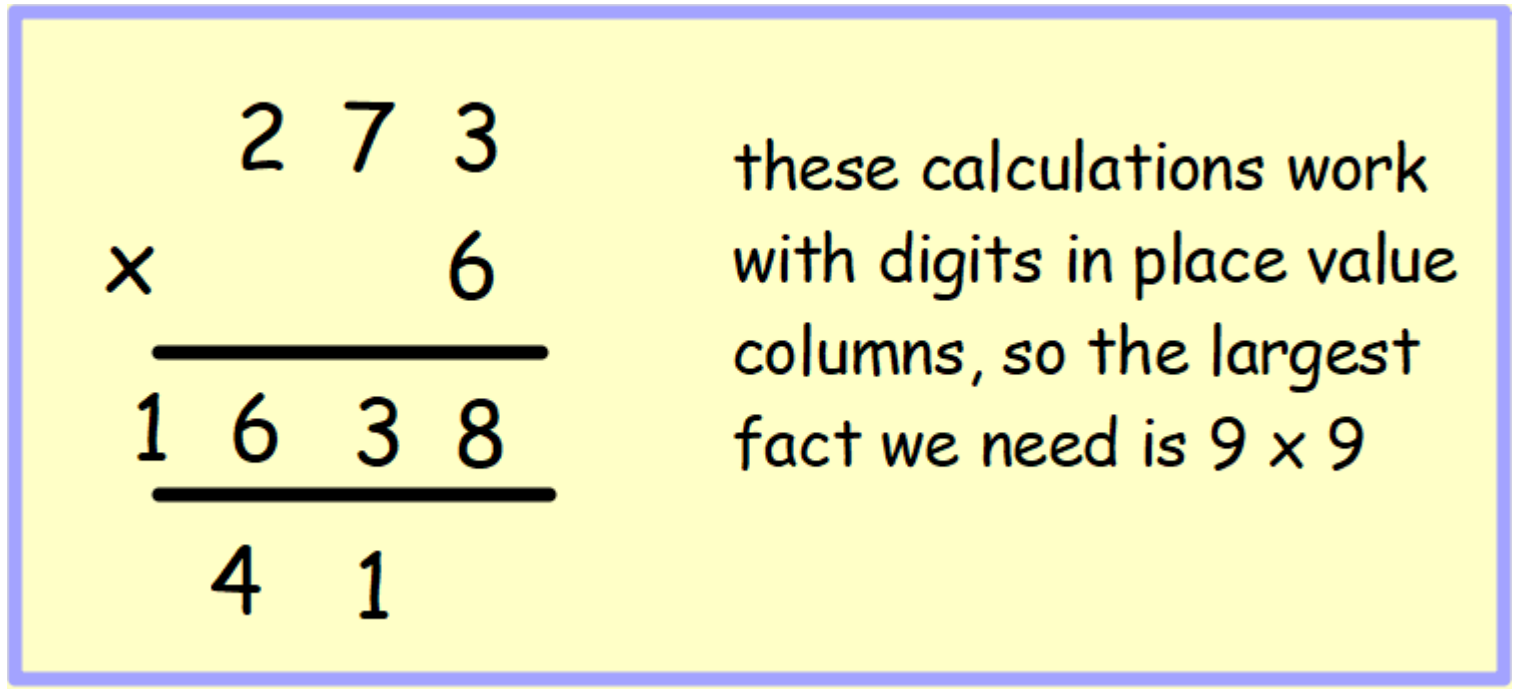
- Systematic, whole class approach to learning the times tables.
- Aims to break down the learning of the times tables into manageable chunks learning a times table at a time (see overview document).
- Importance of the commutative law and the relationship with division facts.
- Rote learning in which children learn the number facts AND a sound pattern (this is important).
- Little and often - A two minute times table test, twice a day.
- 40 questions in each test. The children have two minutes to complete the test. An average of 3 seconds per question.

36 key facts (up to 9 x 9)

- To be learnt across both years in Herons – year 3 and year 4
- To revisit in Year 5 if needed to secure any fact gaps and to deepen children's security and speed of recall.
- To equip year 4 children with the knowledge and speed of recall to perform well in the Government's end of Year 4 Multiplication Test Check (MTC)

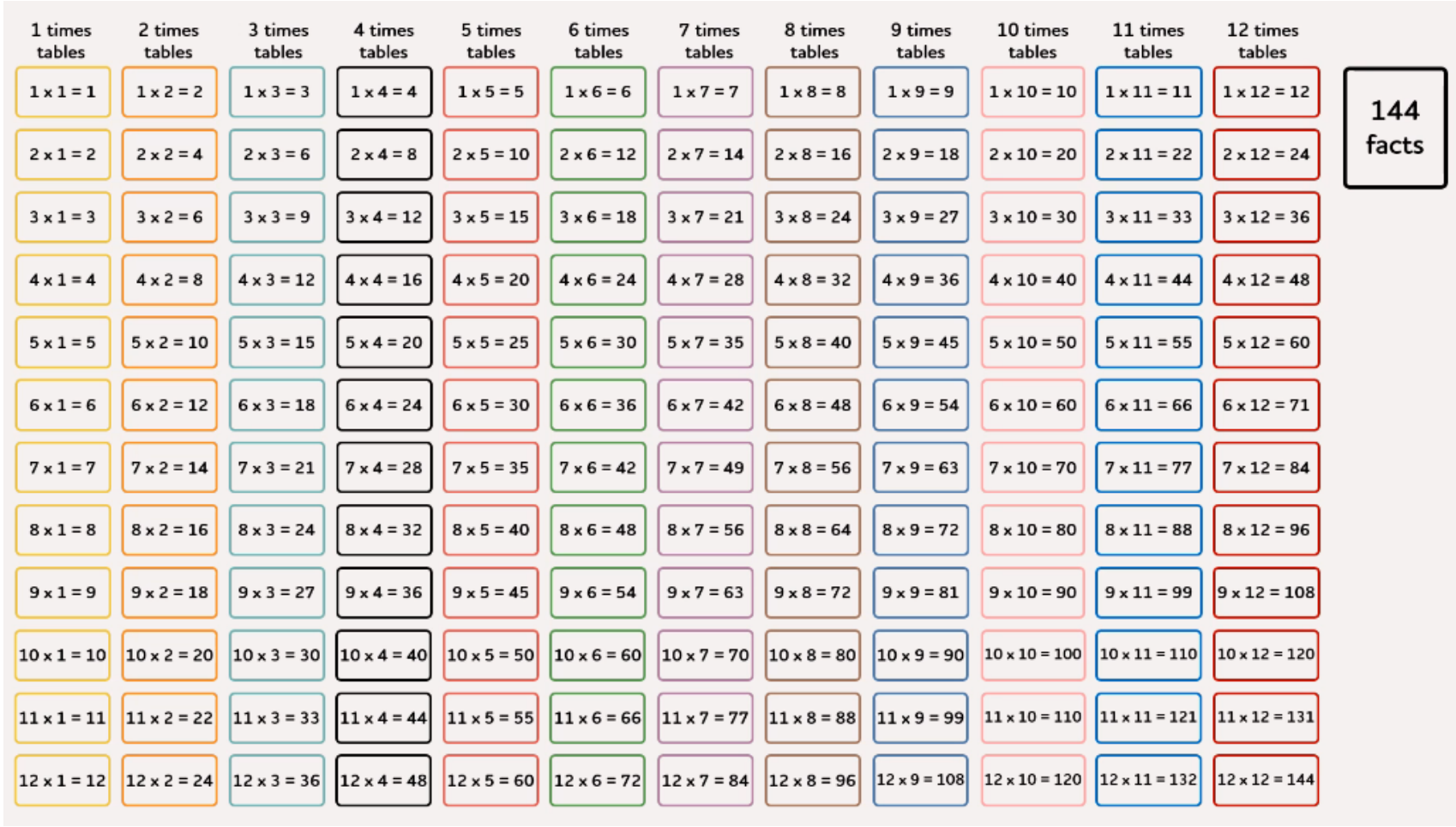
Why do we prioritise facts up to 9x9?

Towards the end of year 4 and moving into upper key stage 2, children will be learning about and using short multiplication and division methods of calculation



How do we break the learning up to make it less daunting?

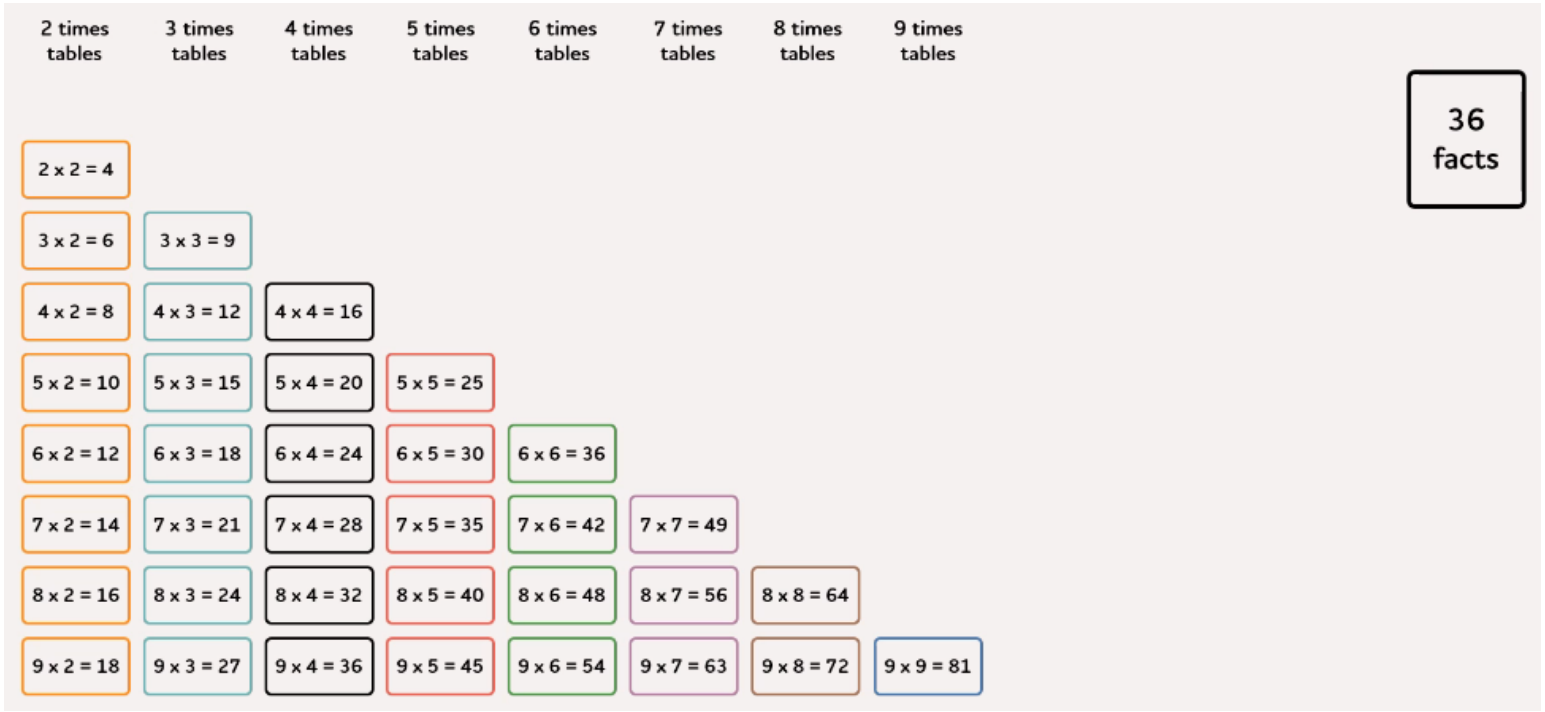
Move to active inspire to model



1 times tables	2 times tables	3 times tables	4 times tables	5 times tables	6 times tables	7 times tables	8 times tables	9 times tables	10 times tables	11 times tables	12 times tables
1 x 1 = 1	1 x 2 = 2	1 x 3 = 3	1 x 4 = 4	1 x 5 = 5	1 x 6 = 6	1 x 7 = 7	1 x 8 = 8	1 x 9 = 9	1 x 10 = 10	1 x 11 = 11	1 x 12 = 12
2 x 1 = 2	2 x 2 = 4	2 x 3 = 6	2 x 4 = 8	2 x 5 = 10	2 x 6 = 12	2 x 7 = 14	2 x 8 = 16	2 x 9 = 18	2 x 10 = 20	2 x 11 = 22	2 x 12 = 24
3 x 1 = 3	3 x 2 = 6	3 x 3 = 9	3 x 4 = 12	3 x 5 = 15	3 x 6 = 18	3 x 7 = 21	3 x 8 = 24	3 x 9 = 27	3 x 10 = 30	3 x 11 = 33	3 x 12 = 36
4 x 1 = 4	4 x 2 = 8	4 x 3 = 12	4 x 4 = 16	4 x 5 = 20	4 x 6 = 24	4 x 7 = 28	4 x 8 = 32	4 x 9 = 36	4 x 10 = 40	4 x 11 = 44	4 x 12 = 48
5 x 1 = 5	5 x 2 = 10	5 x 3 = 15	5 x 4 = 20	5 x 5 = 25	5 x 6 = 30	5 x 7 = 35	5 x 8 = 40	5 x 9 = 45	5 x 10 = 50	5 x 11 = 55	5 x 12 = 60
6 x 1 = 6	6 x 2 = 12	6 x 3 = 18	6 x 4 = 24	6 x 5 = 30	6 x 6 = 36	6 x 7 = 42	6 x 8 = 48	6 x 9 = 54	6 x 10 = 60	6 x 11 = 66	6 x 12 = 71
7 x 1 = 7	7 x 2 = 14	7 x 3 = 21	7 x 4 = 28	7 x 5 = 35	7 x 6 = 42	7 x 7 = 49	7 x 8 = 56	7 x 9 = 63	7 x 10 = 70	7 x 11 = 77	7 x 12 = 84
8 x 1 = 8	8 x 2 = 16	8 x 3 = 24	8 x 4 = 32	8 x 5 = 40	8 x 6 = 48	8 x 7 = 56	8 x 8 = 64	8 x 9 = 72	8 x 10 = 80	8 x 11 = 88	8 x 12 = 96
9 x 1 = 9	9 x 2 = 18	9 x 3 = 27	9 x 4 = 36	9 x 5 = 45	9 x 6 = 54	9 x 7 = 63	9 x 8 = 72	9 x 9 = 81	9 x 10 = 90	9 x 11 = 99	9 x 12 = 108
10 x 1 = 10	10 x 2 = 20	10 x 3 = 30	10 x 4 = 40	10 x 5 = 50	10 x 6 = 60	10 x 7 = 70	10 x 8 = 80	10 x 9 = 90	10 x 10 = 100	10 x 11 = 110	10 x 12 = 120
11 x 1 = 11	11 x 2 = 22	11 x 3 = 33	11 x 4 = 44	11 x 5 = 55	11 x 6 = 66	11 x 7 = 77	11 x 8 = 88	11 x 9 = 99	11 x 10 = 110	11 x 11 = 121	11 x 12 = 131
12 x 1 = 12	12 x 2 = 24	12 x 3 = 36	12 x 4 = 48	12 x 5 = 60	12 x 6 = 72	12 x 7 = 84	12 x 8 = 96	12 x 9 = 108	12 x 10 = 120	12 x 11 = 132	12 x 12 = 144

144 facts

And we end up with 36 key facts to learn



How do we teach the facts?

1 x 6 = 6

2 x 6 = 12

3 x 6 = 18

4 x 6 = 24

5 x 6 = 30

6 x 6 = 36

7 x 6 = 42

8 x 6 = 48

9 x 6 = 54

10 x 6 = 60

11 x 6 = 66

12 x 6 = 72

When we meet a times table for the first time, we write it out in full, to 12 x 6, so children build familiarity of all the facts.

We will then write up the linked division facts so children can see the clear relationship between multiplication and division.

We will learn a fact at a time. Focusing on one a day.

We will reinforce the times table we are practising in school with linked homeworks and at-home practise eg through the use of flash cards.

How do we teach the facts?

1 x 6 = 6
2 x 6 = 12
3 x 6 = 18
4 x 6 = 24
5 x 6 = 30
6 x 6 = 36
7 x 6 = 42
8 x 6 = 48
9 x 6 = 54
10 x 6 = 60
11 x 6 = 66
12 x 6 = 72

As discussed, we will then talk about how we don't need to memorise certain facts:

1 x 6
10 x 6
11 x 6
12 x 6

And how we have already learnt some facts through our other times tables. It is important that children are made aware of their known facts through the commutative law:

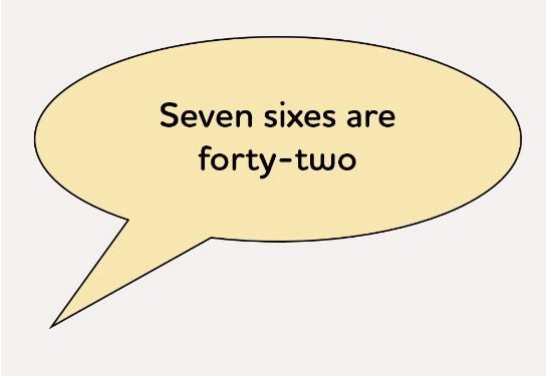
6 x 2 = 12
6 x 3 = 18
6 x 4 = 24
6 x 5 = 30

How do we teach the facts?

1 x 6 = 6		
2 x 6 = 12		6 x 2 = 12
3 x 6 = 18		6 x 3 = 18
4 x 6 = 24		6 x 4 = 24
5 x 6 = 30		6 x 5 = 30
6 x 6 = 36	⎫	
7 x 6 = 42	⎬	new facts
8 x 6 = 48	⎬	
9 x 6 = 54	⎭	
10 x 6 = 60		
11 x 6 = 66		
12 x 6 = 72		

We will then discuss that we only have 4 new facts to learn!

How do we learn the new facts?



We learn each number sentence as a memorised phrase by repeating the sound pattern out loud.

Learn each fact one way round only.
4 x 6 = becomes six fours are twenty four.

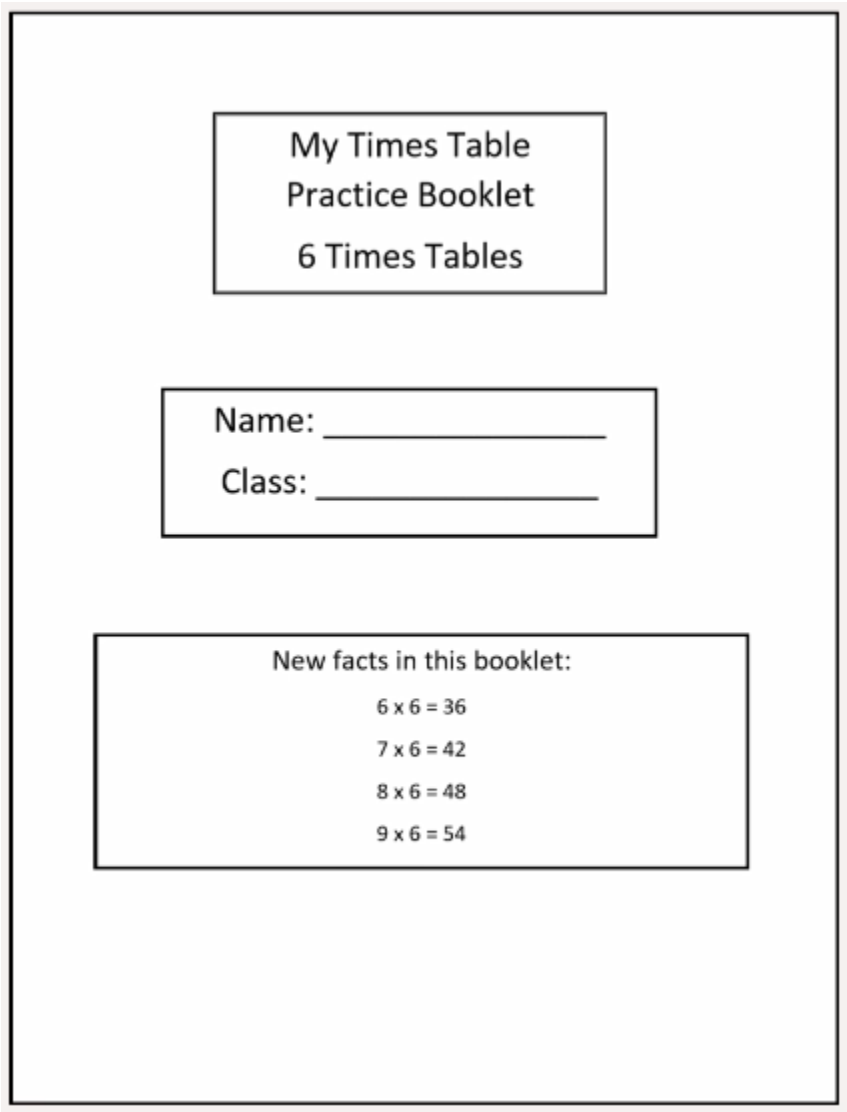
We say them lots of times to promote automaticity. We don't want children to think too hard about knowing the facts…

In time, the children will know them without realising that they do!

"I didn't know I knew that!"

Much like realising you know all the words to a song that you haven't heard for years.

How does the daily practise work?


My Times Table
Practice Booklet
6 Times Tables

Name: _____

Class: _____

New facts in this booklet:

6 x 6 = 36

7 x 6 = 42

8 x 6 = 48

9 x 6 = 54

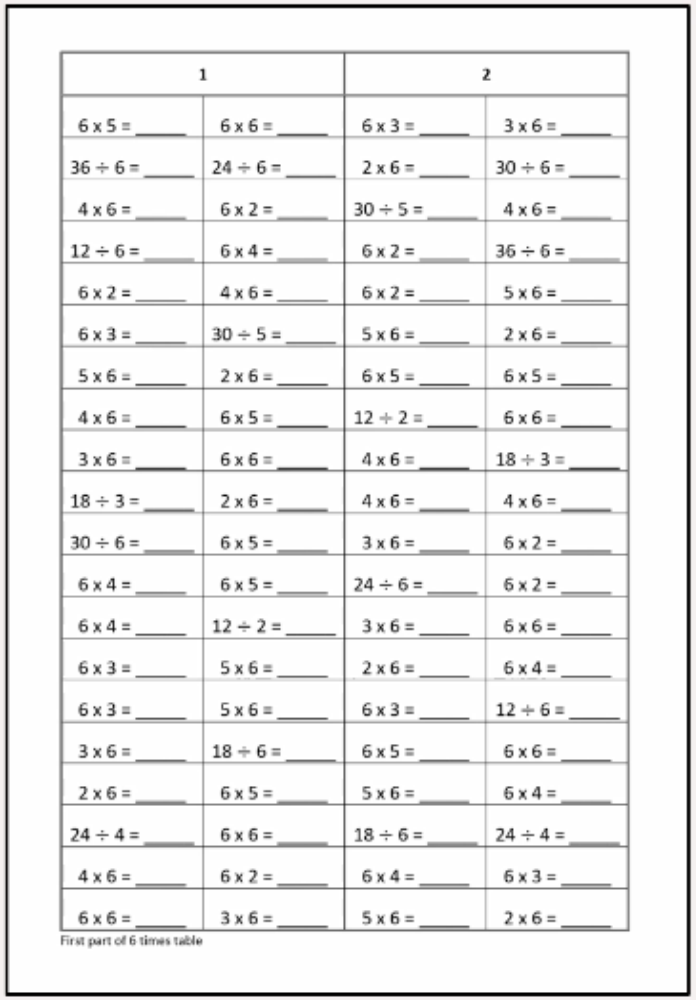
We know there are only 36 key facts to learn by heart.

We learn them as a memorised sound pattern.

How do we get the children to say the new fact enough time to become memorised?

We use simple booklets – a new one each time a new times table is introduced, which highlights the new facts for that times table.

Times table booklet is carefully built up.



1		2	
6 x 5 = ____	6 x 6 = ____	6 x 3 = ____	3 x 6 = ____
36 ÷ 6 = ____	24 ÷ 6 = ____	2 x 6 = ____	30 ÷ 6 = ____
4 x 6 = ____	6 x 2 = ____	30 ÷ 5 = ____	4 x 6 = ____
12 ÷ 6 = ____	6 x 4 = ____	6 x 2 = ____	36 ÷ 6 = ____
6 x 2 = ____	4 x 6 = ____	6 x 2 = ____	5 x 6 = ____
6 x 3 = ____	30 ÷ 5 = ____	5 x 6 = ____	2 x 6 = ____
5 x 6 = ____	2 x 6 = ____	6 x 5 = ____	6 x 5 = ____
4 x 6 = ____	6 x 5 = ____	12 ÷ 2 = ____	6 x 6 = ____
3 x 6 = ____	6 x 6 = ____	4 x 6 = ____	18 ÷ 3 = ____
18 ÷ 3 = ____	2 x 6 = ____	4 x 6 = ____	4 x 6 = ____
30 ÷ 6 = ____	6 x 5 = ____	3 x 6 = ____	6 x 2 = ____
6 x 4 = ____	6 x 5 = ____	24 ÷ 6 = ____	6 x 2 = ____
6 x 4 = ____	12 ÷ 2 = ____	3 x 6 = ____	6 x 6 = ____
6 x 3 = ____	5 x 6 = ____	2 x 6 = ____	6 x 4 = ____
6 x 3 = ____	5 x 6 = ____	6 x 3 = ____	12 ÷ 6 = ____
3 x 6 = ____	18 ÷ 6 = ____	6 x 5 = ____	6 x 6 = ____
2 x 6 = ____	6 x 5 = ____	5 x 6 = ____	6 x 4 = ____
24 ÷ 4 = ____	6 x 6 = ____	18 ÷ 6 = ____	24 ÷ 4 = ____
4 x 6 = ____	6 x 2 = ____	6 x 4 = ____	6 x 3 = ____
6 x 6 = ____	3 x 6 = ____	5 x 6 = ____	2 x 6 = ____

First part of 6 times table

1 2 3 4 — First part of the new times table

5 6 7 8 — Second part of the new times table

9 10 11 12 — The whole of the new times table

13 14 15 16 17 18 19 20 21 22 — The new times table mixed with previously learnt times tables

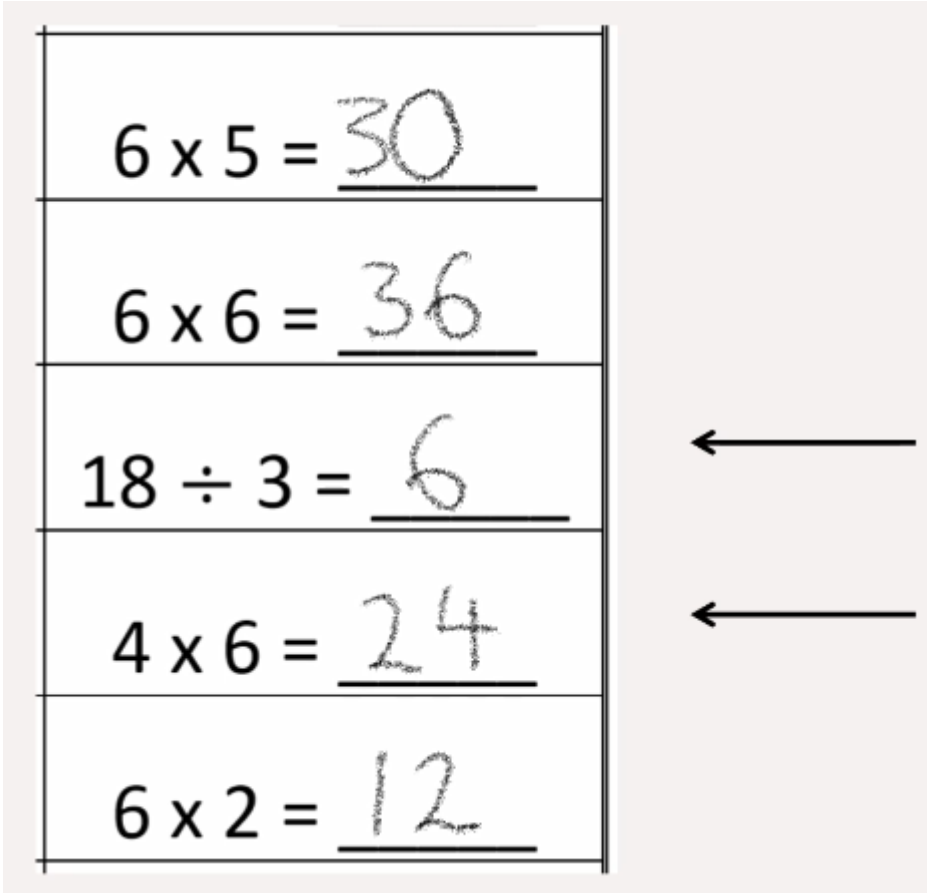
40 questions per test; 2 minutes

Working through the booklet.

- Each test consists of 40 questions. Children are given 2 minutes to complete as many as possible.
- The times table we are working on is ALWAYS on display in the classroom.
- To start with the children might be copying down every fact – there is lots of value in this. It develops their familiarity with the facts.
- As they remember facts, their scores increase. Success is celebrated.
- If they complete within 2 minutes, they note the time they completed in – this becomes their target to beat next time.

Marking – the most important part

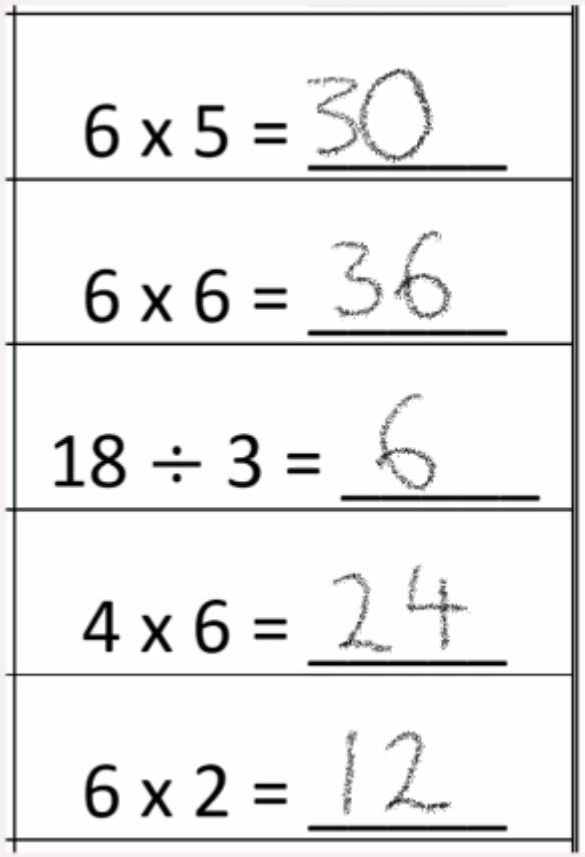
Marking time is actually the learning time.



The teacher says every question and answer aloud, and the children repeat back.

There is a very specific way to do this…

Marking – the most important part



Six fives are thirty
"Six fives are thirty"

Six sixes are thirty six
"Six sixes are thirty six"

Mmm threes are eighteen
"Six threes are eighteen"

Six fours are twenty four
"Six fours are twenty four"

Six twos are twelve
"Six twos are twelve"

It is important to say the fact using the 'sound pattern' that the children learnt. So 4x6 was learnt as part of the 4 times table, not the 6 times table, so verbally, we mark using this sound pattern. Divison facts are linked back to their multiplication fact.

How we mark it

- The children mark their own booklets so that they can fill in any gaps if necessary.
- The full times table fact is read out. We always say the larger number first so that they are only learning one sound pattern for each fact. For example, if the number fact is 6 x 7 = 42, we say seven sixes are forty two.
- The children then repeat that fact back. It's important that every child does this.
- For division facts we say the linked multiplication fact: eg for 18 divided by 3, the teacher would say MMM threes are eighteen. The children then say the learnt times table fact. Six threes are eighteen.
- Once marked the children then share their results with the teacher and identify a number fact they need to learn.

Taking ownership

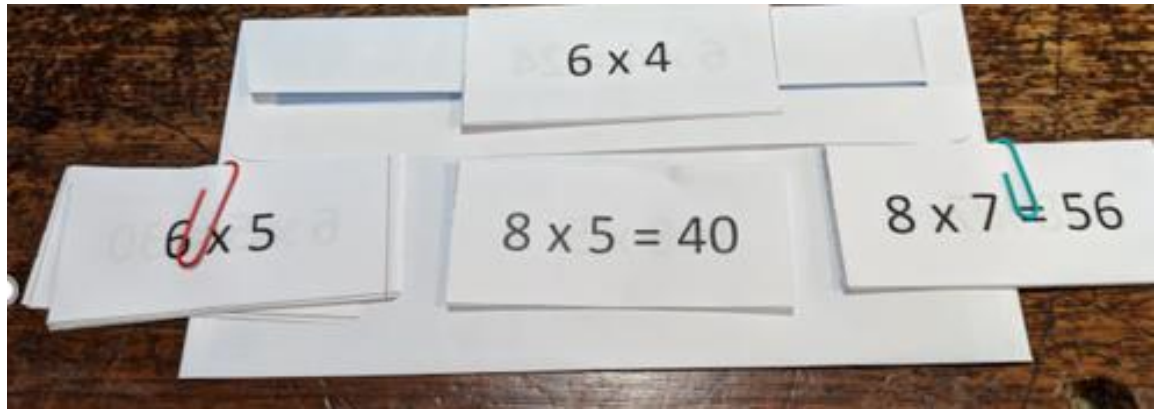
- It is crucial that all teachers engage with the process and take ownership.
- They must know who is 'stuck' and what is the one fact they will learn that day.
- If teachers just hand out booklets and go through the process, it won't get results.
- It is the teacher's job to find the barrier for children who aren't progressing and problem solve past the barrier.
- It is crucial that teachers are enthusiastic about the challenge and create an environment where the children feel excited (and not nervous) about the challenge and encouraging of their peers.

What about children who aren't moving as quickly?

- Important to identify those children that are 'stuck' and unpick the barrier. What is the one fact they will learn that day?
- Envelope system
- Dyslexic children – it WILL be harder but hugely advantageous to learn them and they can do it (contrary to some advice from dyslexia specialists).

What about children who aren't moving as quickly?

- Individual 1-1 intervention for those children who are struggling to remember number facts.
- Guidance provided to parents as to how they can support the individual's learning.
- Start by conferencing the child to identify the number facts they can recall/known facts (green) and unknown facts (red). They then pick two **different** unknown facts and use them as a bookmark to self test before reading.



A quick note on the Year 4 Multiplication Check

More to follow to year 4 parents close to the time

The test consists of 25 questions with 6 seconds to answer per question.

5.2 Assessment content

Items will be selected from the 121 items that make up the 2 to 12 multiplication tables. The one multiplication table is not included in the check, although questions from the one multiplication table may be included as practice questions.

Our new times tables approach covers the 121 facts:

55 facts (the 36 key facts and the remaining x11 x12 that we focus on leading up to the test): we class 3 x 7 and 7 x 3 as the same fact so the children are learning 110 facts; the MTC simply classes them as 2 separate facts.

11 facts in the 10 x tables, which we cover as part of place value teaching

There is research to underpin this new method.

Depth over speed

Jo Boaler: value depth over speed

'One thing we need to change in mathematics classrooms around the world is the idea that in mathematics speed is more important than depth. Mathematics, more than any other subject, suffers from this idea, and the learners of mathematics suffer because of it. **Yet our world's top mathematicians…all talk about working slowly and deeply and not being fast.'**

Boaler, J. Mathematical Mindsets, 2016

Reducing cognitive load

Daniel Willingham is a Professor of Psychology at the University of Virginia and, in 2017, he was appointed by President Obama to serve as a Member of the National Board for Education Sciences.

"I don't think there's much question that kids succeed in mathematics at a much higher rate if they memorise maths facts as part of the curriculum….]"

Willingham also discusses 'cognitive load'. If information is in our long term memory (e.g. multiplication facts), then problem solving using these facts will require less of a 'cognitive load' (essentially less brain power) than if these facts are only in our short term memory.

Willingham, D. https://researched.org.uk/wp-content/uploads/delightful-downloads/2018/07/researchEDMagazine-June2018.pdf 2018.

Reducing cognitive load

Stanislas Dehaene studied mathematics and is a cognitive neuroscientist.

'Within exact calculation, this region [of the brain] is also more active for operations that require a genuine manipulation of numerical quantities, such as subtraction, than for those that can be stored in rote verbal memory, such as multiplication (Lee, 2000).'

**** If multiplication facts are learnt and stored, rather than being calculated or by skip counting repeatedly, then they will require less activity from the brain, reducing the 'cognitive load' and essentially 'freeing up' space to focus brain activity on the application of the facts NOT the facts themselves.**

Dehaene, S.
http://win.pisavisionlab.org/teaching/burr/piazzadehaene_chapgazzaniga.pdf

Verbal memory

Stanislas Dehaene

[There is data]…which indicate[s] that **exact** arithmetic facts are stored in a **language-specific format** in bilinguals, while approximate knowledge is language-independent (Spelke et al., 2001). Moreover, within exact calculation, [they] require access to a **rote verbal memory of arithmetic facts**, such as multiplication, than for operations that are not stored and require some form of quantity manipulation like subtraction.

****Exact arithmetic facts are stored in our verbal memory; saying (and hearing) the sound pattern of the phrase (e.g. seven threes are twenty one) is important.**

Dehaene, S.
http://win.pisavisionlab.org/teaching/burr/piazzadehaene_chapgazzaniga.pdf

Growth mindset

Carol Dweck and Jo Boaler

Carol Dweck is the Lewis and Virginia Eaton Professor of Psychology at Stanford University.

'One area in desperate need of examination is the way we teach mathematics. Many Americans suffer from misconceptions about math. They think people are either born with a "math brain" or not.'

Boaler, J. http://time.com/4717463/jo-boaler-women-stem-ivanka-trump-betsy-devos/ 2017

- Pupils with a growth mindset will make better **progress** than pupils with a fixed mindset.
- There are children who may be more secure with number facts but will make **less progress** in deepening their understanding of other aspects of maths because of their fixed mindsets.
- Pupils with a growth mindset believe that talents can be **developed** and believe that **effort** creates success.

**** Our 'New Times Tables approach' is a great tool for developing growth mindsets as it is a really straight forward system for showing that effort can create improvement and success.**