

How can we build fluency and conceptual understanding of times tables?

Orchard Primary School, Lower KS2 Phase

Abstract

The aim of this study was to explore the methods in which we teach times tables to children in Lower Key Stage 2 (Year 3 and 4) in order to improve their acquisition and fast recall of multiplication facts. The National Curriculum expectation for Primary Schools across the UK is that, by the end of Year 4, pupils can recall all 12 times tables up to 12x12. In addition, the introduction of the Multiplication Tables Check (MTC) for all Year 4 children in 2019 - 2020, (DfE 2019) provides an additional rationale to analyse strategies, raise the profile and enable children to succeed.

Autumn in house data in Lower Key Stage 2 suggested that disadvantaged pupils did not perform as well in comparison to all pupils in maths tests; therefore this research focused on children awarded the additional grant of Pupil Premium (PPG). Over two terms, children followed a structure and timetable for teaching each of the times tables and teachers had a focus timetable each week. Children completed times tables tests in the same format that the statutory tests will take and results were recorded. All teachers involved in the study saw a positive impact on pupil outcomes from their starting points. They also felt more confident and more engaged in teaching the concepts of times tables.

Introduction

Orchard is a larger than the average-sized primary school situated next to a large housing estate in the vibrant and diverse London Borough of Hackney. The majority of pupils are from minority ethnic backgrounds and most of them speak English as an additional language. The proportion of pupils eligible for the pupil premium is significantly higher than the national average and a significant number of children who enter EYFS are below the age expected level in all areas of learning.

In response to the Government's introduction of the Multiplication Tables Check, a new way of testing children's times table ability was introduced across the Federation from Years 3 - 6 in September 2018. Each child was given an individual login for the program, *Know Your Pupils*. This online test was completed on a laptop with a total of 40 questions to be answered every 5 seconds. This platform was chosen as it presented the test in the same way as the Multiplication Tables Check and produced clear diagnostic reports that could be used to inform assessment and planning. The purpose of the Multiplication Tables Check to determine whether pupils can recall their times tables fluently is essential for future success in mathematics. It aids the identification of pupils who have not yet mastered their times tables so that additional support can be provided. Through baseline testing it became apparent that the percentage of children in-line to reach a 100% pass rate was poorer than expected. It was also clear that disadvantaged children were scoring significantly less than all pupils.

Through conversations within phase meetings regarding fluency, reasoning and problem solving in maths lessons, it was a notable point of discussion that children's inconsistency in quick recall of times tables was preventing them answering questions correctly or effectively during application. Prior to the research beginning, the approach to the teaching of times tables was inconsistent across the phase and teachers were using a variety of methods with limited evaluation of selecting approaches for impact. As a principle of the research, it was agreed that if the children were confident in knowing their times table facts, thus storing these facts to long term memory, then application of these to more complex learning such as problem solving would be improved.

According to Richardson (2018), 'a recurring theme across Mathematics teaching in primary schools is the lack of instant recall of times tables and multiplication facts'. From teacher assessment this was evident in the children's outcomes within the setting. With the development of the maths curriculum (White Rose 2017), knowledge of the implication of a lack of conceptual understanding of times tables was understood by teaching staff. Park and Nunes (2000) state that even more than knowing

multiplication facts, understanding quantitative relations between multiplication is critical for developing children’s maths reasoning abilities and their future learning in science or engineering domains.

Identified ways in which times tables were being taught were discussed and different ways in which children could be taught to both recall and understand the concept behind each times table in order to apply their knowledge were agreed. ‘Children benefit from receiving repeated opportunities to count, then figure out before remembering. To jump straight to ‘remembering’ causes pupils to experience the known difficulties of being prematurely exposed to abstract concepts.’ (Parkinson 2016).

Research Process

The project was co-ordinated by the Phase Leader and supported by six teachers within Lower Key Stage 2. At the beginning of the research project all teachers met and discussed the teaching of times tables and looked at the assessment results from Autumn times table tests, (Fig. 1).

Times table Overview Autumn (8 test average)			
Year	% at 4 tests	% at 8 tests	Below 20%
Year 3	21.6%	22.6%	41 children 27 children disadvantaged (66%)
Year 4	30%	33.8%	15 children 10 children disadvantaged (66%)

Figure. 1 Times table Overview Autumn (8 test average)

All children in Years 3 and 4 were given the same provision yet to measure impact a focus group was chosen. This was based on children’s Autumn assessment data. Every child in the study was given a questionnaire at the beginning of the research to establish the current attitudes to times tables, (Appendix 1).

Through our discussions, it was decided there would be a times table focus of the week which would be displayed in the classroom and introduced each Monday. This

raised the profile of times tables but allowed the children to make links back to one times table throughout the week and feel successful. The focus times table was taught as Monday's mental and oral starter and practised throughout the week prior to mental oral starters in a 'two minute times table' pre starter. Using times across the day in spare minutes such as, lining up before lunch or time before a specialist session began were used to revisit and consolidate. Each year group followed the same sequence of focus times tables initially with the expectation that learning past Monday was responsive to the pupils' needs to address gaps in knowledge.

Ways in which times tables were discretely taught was an active agenda item within weekly phase meetings which ensured a continuous professional dialogue. Teachers shared their methods such as the use of a counting stick for children to identify missing numbers, "what is double 3 x 6?" The use of hundred squares to identify patterns within times tables as well as the quick tricks such as counting the nines on your fingers were also shared and taught within each class. Making connections between the times tables, identifying patterns and teaching division were also shared amongst the team for teachers to implement in their own class. CPD and quality assurance from the Maths Lead ensured that ideas were shared and tried in class.

It was decided to teach the children 'rolling numbers' times table chant for each times table. This combined call and response chanting of the times tables while counting each multiple on fingers, (Appendix 2). Each song has a different rhythm and specific hand motions and a child acted as the leader. The nine times table was introduced first, followed by three and six, seven, eight and four. This order was decided upon as links between times tables could be easily made to support children's understanding.

As the program developed, teachers could see that children's attitudes to learning their times tables changed. They were enjoying the new games and songs that they were using and as a result often wanted to roll a certain times table over another. In addition, class teachers found that children were practising the times table of the week at home and eager to share work done at home with the class. In some classes this was displayed which had a positive impact on other children too.

At the end of the project, all children participating in the focus group were re-assessed using the online test and given the same questionnaire to complete. The phase lead also met with class teachers to discuss their views and opinions on the project and also completed a questionnaire.

Findings

The children responded very well to the rolling number songs and quite quickly there was a noticeable difference in engagement in whole class chanting. Teacher's expressed that the songs motivated the children as they were eager to be chosen to be the leader. Children were also keen to learn which times tables was to be the focus for that week as well as demonstrate their progress. The introduction of new games such as times table 'ping pong' and 'rock, paper, scissors' promoted love of learning and many children enjoyed the competitive nature which encouraged faster recall of times table facts.

After comparing the questionnaires from the beginning and the end of the study, it was clearly shown that children enjoyed learning their times tables more. The graphs below also evidence the change in children's perception of their ability and how they value the acquisition of times tables knowledge, (fig.2).

I enjoy learning my times tables

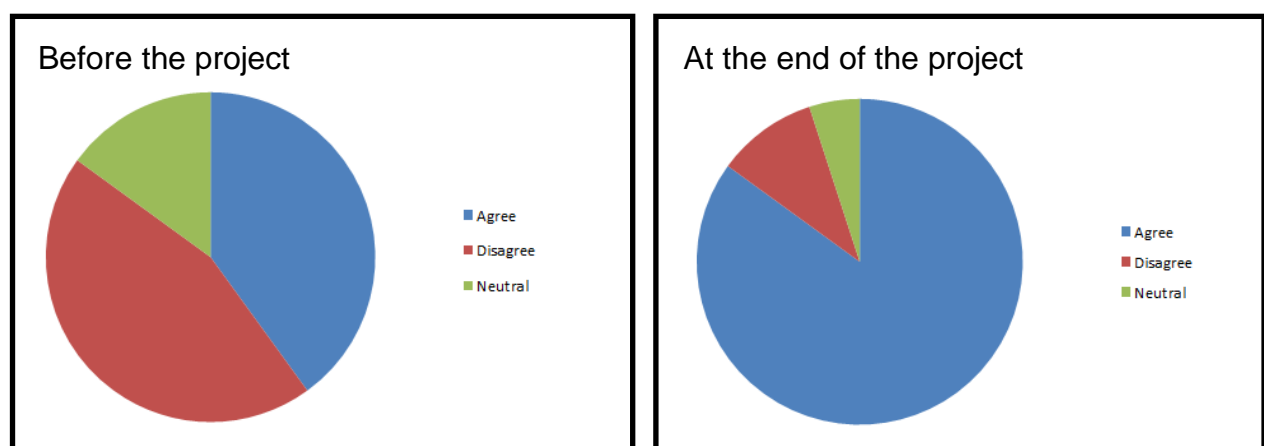


Figure 2. Results of questionnaire before and after implementation of strategies

In addition, children’s perception of their ability had also altered. Before the test children lacked confident in their ability and after the focus on times tables teaching they demonstrated a greater level of confidence in their own ability, (fig.3).

I am quick at remembering my times tables

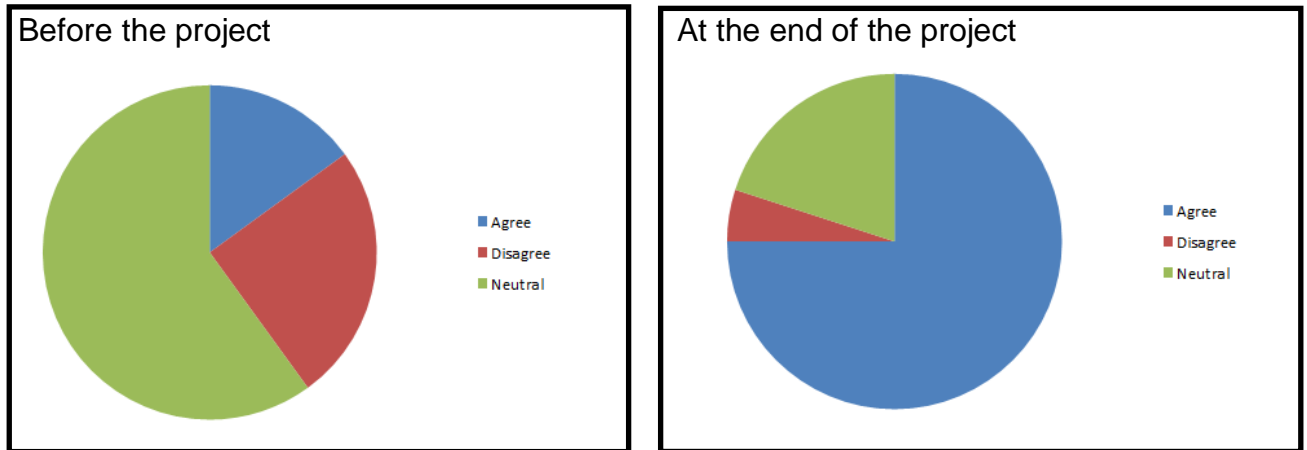


Figure 3. Results of questionnaire before and after implementation of strategies

The average score at the end of Spring Term on the online tests had increased across the phase, (fig. 4). The children who achieve less than 20% had significantly improved and the average test score had also increased in both year groups. However the disadvantaged in this group continued to be significantly high. In this term, completion of these tests was changed from once every two weeks to twice a half term to ensure more time was spent on the teaching the concepts of times tables.

Times table overview Spring (16 test average)					
Year	% at 4 tests	% at 8 tests	% at 12 tests	% at 16 tests	Below 20%
Year 3	21.6%	22.6%	26.2%	33%	23 children 15 disadvantaged (65%)
Year 4	30%	33.8%	39.5%	44%	7 children 6 disadvantaged (85%)

Fig. 4 Times table overview Spring (16 test average)

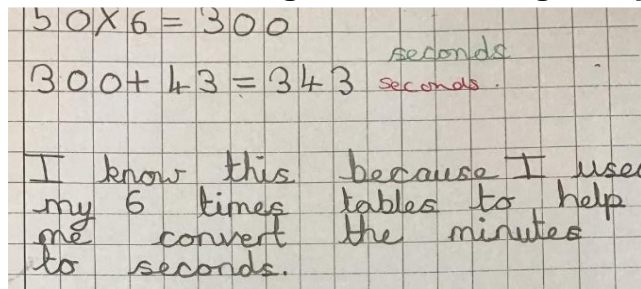
Times table overview Summer (18 test average)						
Year	% at 4 tests	% at 8 tests	% at 12 tests	% at 16 tests	% at 18 tests	Below 20%
Year 3	21.6%	22.6%	26.2%	33%	45%	11 children 11 disadvantaged (100%)
Year 4	30%	33.8%	39.5%	44%	59%	4 children 1 disadvantaged (25%)

Fig. 5 Times table overview Spring (18 test average)

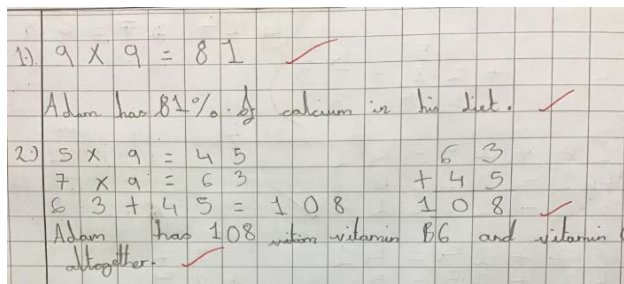
Fig. 5 shows the data after eighteen tests. Since Spring term data collection point, the average for Year 3 pupils had increased by 12% and in Year 4 14%. This is a steady increase yet could be improved upon further. Disadvantaged children continued to perform less well in online tests than all pupils, however there was still progress being made from their starting points. Results from the tests were inconsistent and this could be for many reasons. Most tests were administered as the children come in to school, if a child was late this would have a detrimental effect to their focus and concentration. Another factors identified were the amount of parental support and experience of using a laptop. From observations, many children were able to recall the answer using their times table knowledge yet being able to locate the correct answer and input it on the laptop remained a challenge in the five seconds time frame.

Evidence of improvement in the application and understanding of times tables were found in the children's maths books. Fig. 6 shows children applying their times table knowledge in different situations such as reasoning in different contexts; thus proving the children have a greater conceptual understanding of the mathematical processes behind time tables.

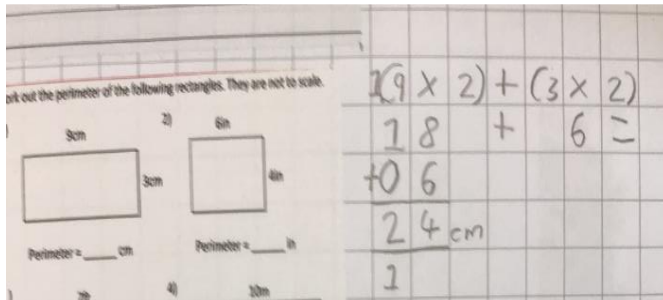
Fig. 6
Year 3 disadvantaged child working at expected



Year 4 disadvantaged child working at greater depth



Year 4 child working at expected



Impact and conclusion

The aim of the project was to broaden the ways in which times tables were being taught in order for children to build fluency and develop conceptual understanding in order to apply knowledge. The study received positive feedback from the teachers; many of which acknowledged the professional development it has provided Teachers were more confident in the teaching of the conceptual understanding of times tables and these strategies are taught instead of just relying on recalling and remembering. They also have a wider toolkit to teach these skills and practise quick recall too (Appendix 3).

This in turn has had a positive impact on children's enjoyment and engagement in times tables. Children have been engaged in the focus times table and enjoyed the challenge that it sets themselves at the beginning of each week. The project was easily facilitated and teachers have expressed a desire to continue teaching the children the rolling numbers chants as they feel this continuity will support the children as they move through the school; particularly from Year 3 to Year 4.

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Appendix

Appendix 1

Questionnaire given to a select group of children before and after the project.

1.	<i>I like learning times tables</i>			
2.	<i>I think learning times tables is important</i>			
3.	<i>I know most of my times tables</i>			
4.	<i>I am quick at remembering my times tables</i>			
5.	<i>My favourite way to learn times tables is...</i>	<hr/>		

Appendix 2

Rolling Numbers

To help us become faster and more accurate at our times tables we are learning to 'roll our numbers'.

As we call out each number we put another finger up.

Nines

Leader: I've been telling everyone how good you are at maths.

Class: No lies, true say.

Leader: Can you roll your nines?

Class: Yes!

Leader: Team! Team! Good as gold! Let me see your fingers roll... the nines!

Class: 9-18-27-36-45-54-63-72-81-90-99-108

(counting off on fingers as you go)

Leader: (Nod)

Class: Whoomph! There it is! I said whoomph! There it is!

Threes

Leader: Team! Team! Good as gold! Let me see your fingers roll... the threes!

Class: Yeah!

3-6-9-12-15-18-21-24-27- 30 and 33-36!

Uh huh. This team's got it going on, going on. Oh yeah!

Sixes

Leader: Team! Team! Good as gold! Let me see your fingers roll... the sixes!

Class: Yeah!

6-12-18-24-30... 36-42-48-54-60

Leader: And team ____ says...

Class: 66, 72. How'd you do? How'd you do?

We can do our sevens too!

Sevens

Leader: Team! Team!

Good as gold! Let me see your fingers roll... the sevens!

Class: Yeah!

(Army style)

7-14-21 STOMP STOMP! 28-35 STOMP STOMP!

42-49 STOMP STOMP! 56-63 STOMP STOMP!

70! (Both hands up with 10 fingers outstretched for 70),

77-84 STOMP STOMP!

If you want, we'll give you more.

Eights

Leader: Team! Team! Good as gold! Let me see your fingers roll... the eights!

Class: Yeah! 8-16-24-32-40

40 down here (punch palm once) 40 up there (palms up)

48 (punch palm twice) 56 (punch palm twice)

64-72-80

80 down here (punch palm once) 80 up there (palms up)

88 (punch palm twice) 96 (punch palm twice)

Now stop suddenly with your arms folded, leaning back like you're tough.

Fours

Leader: Laurel! So smart in here!

Class: Yeah!

4-8 (mini-pause) 12-16 (mini-pause) This is how we roll our fours...

20 (pause) 24-28 (pause) 32-36 and 40

44 uh-huh 48 uh-huh! (pause) No doubt (pause) we rock uh-huh uh-huh

It's KSA in here, we'll show you all we know.

We are (mini pause) getting so smart! We are getting ready!

With a little bit of work hard. (mini pause) And a little bit of be nice. Uh-huh!

With a little bit of work hard. (mini pause) And a little bit of be nice. Uh-huh!

It's KSA in here, we'll show you all we know.

We are (mini pause) getting so smart! We are getting ready!

With a little bit of work hard. (mini pause) And a little bit of be nice. Uh-huh!

With a little bit of work hard. (mini pause) And a little bit of be nice. Uh-huh!

It's Laurel in here, WE'LL SHOW YOU ALL WE KNOW!

Appendix 3

Teacher questionnaire completed individually at the end of the project

1.	<p>At the beginning of the year what strategies did you use to teach times tables?</p> <ul style="list-style-type: none"> • Time Table tests • Writing out the times tables x3 • Chanting • Quickfire questions at the start of a lesson or when they were lining up. • Hit the button
2.	<p>What resources in your room do you have that facilitate the acquisition of times tables?</p> <ul style="list-style-type: none"> • Times table of the week focus x 5 • Timetables grid on display x 3 • Key children have own times table grid x 3 • ActivInspire x 3
3.	<p>What impact has 'rolling numbers' chants had on your class? Include any key groups (disadvantaged, ethnicity, ability)</p> <ul style="list-style-type: none"> • Children show enthusiasm and are excited to do the 'rolling numbers'. Lower ability children are much more involved in the active learning of times tables. • They are able to self lead it and enjoy it. No matter their ability, due to it being a fun chant, they can all take part and they feel as part of a team. • Positive impact, children enjoy chanting and use it in their tests
4.	<p>What strategies do you now use for times table teaching?</p> <ul style="list-style-type: none"> • Rolling numbers songs x 6 • 100 square grid to identify patterns x 4 • 100 square to identify common links with other tables x 4 • Hit the button x 2 • Counting stick x 4 • Times table ping pong x2 • Hiccough on the counting stick x4 • Rock paper scissors x4 • Mixed ability group time table challenges • Around the world
5.	<p>Which method is the most effective and why?</p> <ul style="list-style-type: none"> • Rolling numbers and the 100 square as it helps with route learning as well as visualising the times table pattern. • I think they all have an effect in different ways but children seem to enjoy the rolling numbers chant as it is fun and they can lead it themselves. They use it in their tests. • Timetables Ping-Pong as children are very enthusiastic about it • Rolling numbers because it helped with visualising the time table pattern
6.	<p>What do you think are the barriers for disadvantaged pupils in the rapid recall of times tables to succeed on the online tests?</p> <ul style="list-style-type: none"> • Many of the children do not practise at home and are therefore unable to rapidly recall the times table in 5 seconds. • They may not have the right resources at home i.e. access to a computer to help them play online games. Language could be a barrier if parents aren't English speakers so may not be able to support their child. • Time constraints of the online tests