Teaching, learning and understanding times tables, a case study from the perspective of schools participating in a national CPD programme

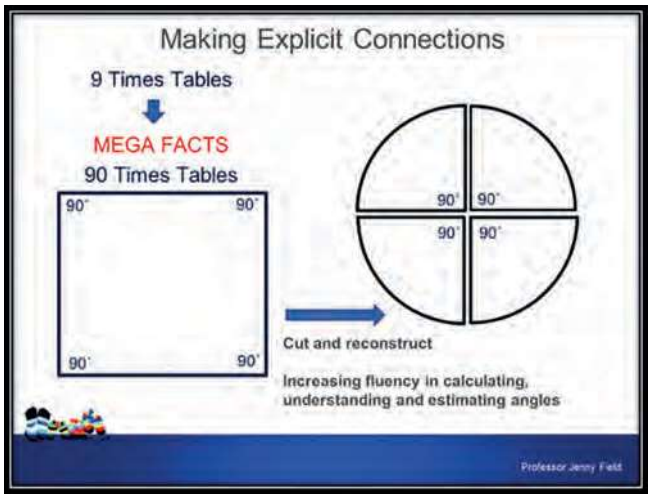
Jenny Field invites **Allie Day** and **Sunita Vyas** to describe their experiences of the DfE funded Times Tables Programme which she designed and led

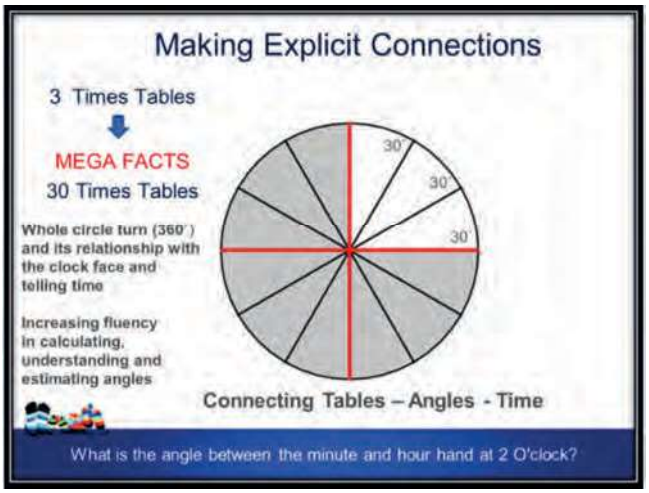
In 2017 the Government announced a plan for a new statutory Multiplication Tables Check (MTC), to be introduced in Year 4 from June 2020 (delayed to 2021 due to Covid-19). Initial concerns prompted me to design a year-long CPD Programme, 'Whole school approaches to teaching, learning and understanding times tables', aimed at Mathematics School Leaders. This article considers the programme from the perspective of two participants – mathematics leaders within their schools. The programme itself has been funded by the DfE, through the NCETM and is a South East London Maths Hub Innovation Work Group; it comprises 4 pre-requisites and 8 whole school steps. The pre-requisites encourage participants to consider what children must already understand, at the very least, before they embark on embedding times tables in a structured way within their settings – more details can be found in my earlier article in Primary Mathematics (Field, 2020 pp. 17–22). Since 2018, over 100 schools across 5 local authorities have participated, as well as a 'Train the Trainer' model for other providers, including United Learning – the largest teaching academy chain with over 70 schools from Kent to Cumbria.

The impetus to design the programme grew from a desire not to see increased focus on pedagogical approaches based solely on memorisation, putting children '*on the spot*' and '*drill and practice*' without meaning. I felt strongly that this would result in increased mathematical anxiety in a subject where expertise and speed already appear inseparable (Donaldson et al, 2012, Boaler, 2016). Why has mathematics developed the reputation of a discipline which often appears to reward speed over depth of understanding? I have witnessed many lessons which have demonstrated an embedded culture of '*question firing*' at individuals – initiating that rising feeling of panic, the knot in the stomach and the common '*could you repeat that, I didn't hear*' response, to buy some time – and sadly in many children (and adults) this breeds a dislike of the pressure that mathematics is seen to bring, and a lack of understanding of the joy it can truly offer. I remember a teacher once telling me that they had caught a child sneaking back into class to remove their name from a pot on the desk from which the teacher would randomly select a child to answer a question – interestingly whenever I feign the suggestion of using a similar '*pot*' approach with a roomful of maths leaders they often look understandably horrified! In all fairness, I believe many schools have now moved away from this approach – however my concern is that the MTC could provide an enticing step backwards.

Nevertheless, these feelings are juxtaposed with my belief that the ability to retrieve some basic mathematical facts without effort, including times tables, decreases cognitive load (Sweller, 1998), allowing children to fully engage in more complex problems. This led me to attempt to design a programme which might influence whole school practice in ways that supported retrieval of facts, in preparation for the MTC, while simultaneously improving multiplicative reasoning within a mastery curriculum. In addition, with the pressures of an excessively full National Curriculum, being able to

target more than one objective in a connectionist approach (Askew 1997) could have compound benefits.

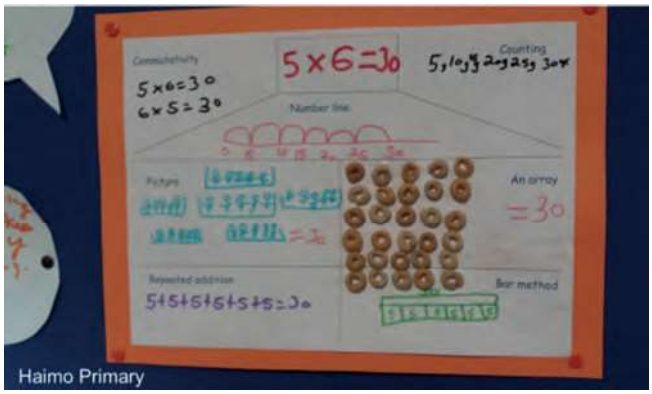




The Organisation for Economic Cooperation and Development (2019) drawing upon PISA research, indicates that the UK already appears to have the highest use of memorisation of all OECD Countries, including those obtaining higher results in PISA league tables. This could be because rote learning methods are unlikely to empower children by exposing mathematical relationships and structures (Parker 2019). My fundamental belief is that *automaticity*, as described by Fosnot et al (1985) is more powerful than *memorisation*.

'Memorization of basic facts usually refers to committing the result of operations to memory so that thinking is unnecessary … teaching facts for automaticity in contrast relies on thinking. Answers to facts must be automatic but thinking about the relationships among the facts is critical. A child can then think of 9 x 6 as (10 x 6)– 6'. (Fosnot and Dolk 2001:85).

This idea of automaticity over memorisation also fits well within our NC, which states *'fluency and conceptual understanding are developed in tandem*



because each support the development of the other'. We do not want any children to learn rote facts for a test in Year 4 and then be unable to retain them. Better to automate them via deeper understanding which then leads to greater mathematical flexibility – at the very least this will go on to support their success in the Year 6 SATS! Anything else could be a short-sighted use of time – and there is no time to waste with our overly packed National Curriculum. Learning times tables should not be a '*bolt on*' that sits outside a mastery curriculum.

Research has always been an integral part of this programme – attempting to identify the impact of long term CPD on professional development, whole school practice and pupil engagement and attainment. Cumulative data over 3 years shows that over 93% of participants felt the subject knowledge of staff within their school had deepened; 100% stated that this was also the case for their own subject knowledge; 96% felt that during the programme there had been key changes in the ways they approached the teaching and learning of times tables, with an increased focus on a whole school approach. In addition, one of the key trends was the importance of an extended CPD programme – a programme with structured gap tasks, a 'step by step' research driven approach to change with networking opportunities for reflection and growth. This was considered by many to be vital for the sustained professional development of school leaders of mathematics. This article now presents a case study of two such mathematics leaders who have completed the programme and write from their own perspectives.

Sunita Vyas

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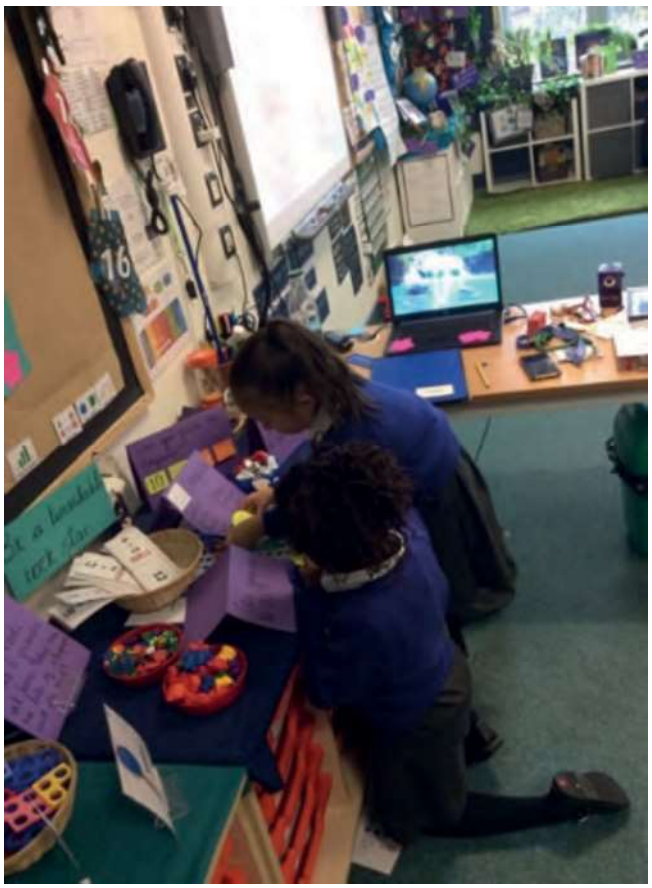
Following on from a discussion around fluency and recall of essential number facts, Foxfield

Primary School decided to take part in the times tables programme led by the Greenwich University in partnership with the SE London Maths Hub. We had identified that children who had a secure understanding of their times tables were far more able to work efficiently through calculations and apply their knowledge to more complex problems. In order to avoid '*building on sand*,' we knew that collectively, we needed to embed a systematic way of teaching these skills, ensuring sufficient opportunities for practice and recall.

The programme consisted of several half day sessions at the University of Greenwich, spread out over the course of the year. The structure of each session included opportunities to develop subject knowledge, reflect on current practice within the school and decide on actions for implementation or dissemination of learning. Being able to network with other maths leads from across the hub was particularly useful, giving leaders the opportunity to discuss our progress and consider challenges we had faced, which we were then able to work through together. The fact that the programme ran over a year was a feature that aligned well with our current research-based practice within the school. This allowed us to undertake a slow, measured approach to the implementation, where I was able to carefully plan and deliver CPD sessions within the school that ensured consistency in subject knowledge and a shared vision for what we wanted the teaching of times tables to look like. The gap tasks supported this model of collaborative learning, allowing me to work closely with year groups and gather pupil and teacher voice post trialling particular approaches, giving me time to consider which approaches would have the most impact for our pupils, given their starting points.



As both a maths lead and class teacher, I found the opportunity to develop my practice through a research-based model particularly effective. The sessions included a balance of professional learning, pedagogy and subject knowledge development. This meant that I had a clear understanding of the strategies, which I was able to trial and refine in my classroom before developing this with the teachers. Having already been on the mastery journey, there was already a strong understanding amongst staff of the importance of small steps, developing coherence and the CPA approach to learning. Together, we were able to build on this and implement a research driven 'core representation' to enable consistency in teaching and clear progression across the school for all learners and year groups – the array.

In order to develop multiplicative reasoning, we had to factor in that children first needed to have a strong understanding of the concept of zero, be able to unitize, understand equal and unequal groups, combine equal groups and understand the relationship between repeated addition and the times sign. With this in mind, we designed a whole school progression map that incorporated the sequential building of knowledge, starting with reception. We felt that as a school, the array representation would support the structures that were already being used in school to develop fluency and mastery. The embedded use of ten frames in the early years, alongside Number Blocks, formed the foundation for the use of arrays, and the bar model in year 1 and beyond. One focus of the taught sessions was

the use of subject specific language throughout the school, which we decided upon as an SLT to ensure that terminology such as multiplicand, multiplier and product were integral in building strong conceptual understanding from the beginning. We moved away from using the traditional hundred number squares, and created array hundred squares, designed to encourage children to count groups, further developing multiplicative reasoning in both times tables sessions and beyond.

In line with the school progression map, class teachers present the 'focus' times table for the half term in the form of a physical multiplication table display. The table comprises a rich variety of provocative questions and problems for the class to solve, visual cues and prompts and a range of representations of that times table. When first introduced, the children also explore real life patterns or objects they come across that occur in groups of that times table and add their own ideas to it.

Following on from this, explicitly taught times tables sessions have been integrated into the school timetable, which are exclusive of maths lessons and take place 2 to 3 times a week. The focus of these lessons is developing conceptual fluency through the array hundred squares and other manipulatives, exploring patterns and structures and allowing children to represent and manipulate multiplication facts. There is a sustained focus on mastery, intelligent practice and variation. These sessions are followed up during maths lessons and during starters, where children practise rapid recall of multiplication facts through engaging games and quizzes, taken from a bank of high-quality activities and supported initially with conceptual representation. During these sessions, teachers have enjoyed innovating their use of the counting stick and incorporating 'Kagan' cooperative learning strategies to engage pupils and develop fluency. As a school we recognised the importance of ensuring that there is a balance between developing conceptual understanding and providing time for children to practise and revisit facts.

Parental engagement has been a key factor for us within our setting. We wanted to establish a shared clarity over the teaching of times tables with our parents and carers and empower them with the vocabulary, structures and representations so they can support their children at home. To this end, we ran parent workshops with the adults and children, focusing on how they could bring multiplication and times tables to life through their everyday routines. Open mornings were also extremely popular as was inviting parents into the classrooms to participate in times table sessions with their children.

Overall, the project has been fundamental in helping to develop a consistent, whole school approach to the explicit teaching of times tables. Having participated in the Multiplication Tables Check in June of 2019, we already saw a notable impact. Empowering the teachers with the necessary subject knowledge and pedagogy has enabled them to carefully craft lessons which allow all children to achieve depth of learning. Moving forward, we are working to use our learning from this project to enhance the way arithmetic skills are taught in different year groups over the year. If our success from this times tables programme is anything to go by, we are excited to see what impact this could have

on developing the foundations of essential skills, in order for our children to achieve mastery and depth of learning across all areas of maths.

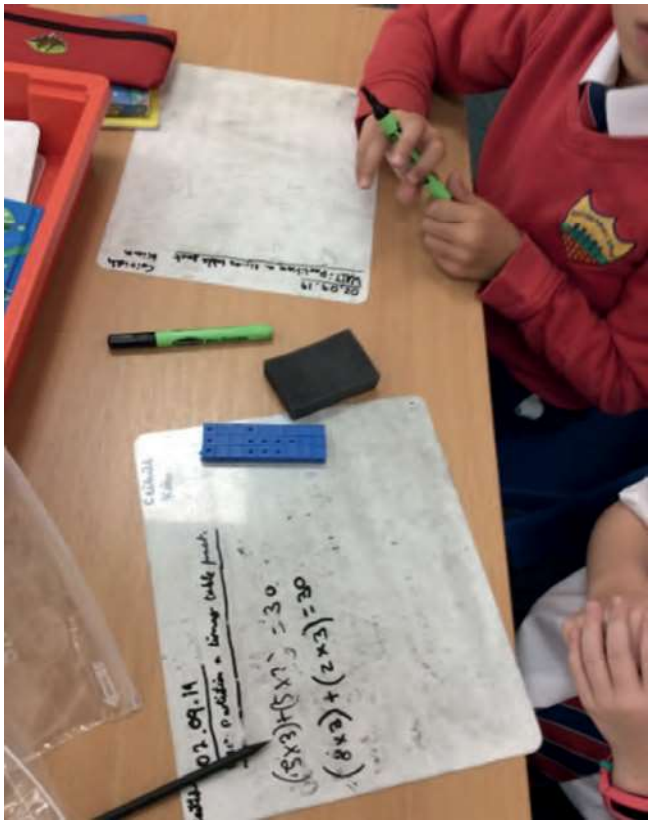
Allie Day

Red Hill Primary School (The Pioneer Academy), Chislehurst, Kent

Red Hill Primary School is part of The Pioneer Academy and it was agreed that all the schools across the education trust would be part of the times tables project. As a group of mathematics curriculum leaders, we were eager to prepare our lower KS2 pupils for the requirements of the 2019/20 Multiplication Tables Check and ensure all pupils across the education trust benefitted from a

focus on mathematics fluency and application.

Two members of the mathematics team at Red Hill Primary School attended the training. The half day sessions spread over the year gave us a chance to reflect on the training and disseminate the ideas, firstly within our own year groups and then wider through short bursts at our weekly staff meetings. Being able to meet with other maths leads, not only from our education trust, but from other schools was very useful; the exchange of ideas, practical tasks and discussions gave us food for thought. We were able to return to each new session with examples of ideas we had trialled and discuss their impact. It was interesting to see how other schools had interpreted the gap task and to exchange ideas. The ongoing CPD throughout the year, kept the project foremost in our minds and ensured we gave staff new ideas and perspectives. I found the professional logs kept me on track with the gap tasks and enabled me to reflect on the impact we were having on the way we taught times tables within my year group and across the school.



For me personally, I gained a chance to think more carefully about my own subject knowledge and lesson design for this aspect of mathematics. All of the practical activities that we were shown reassured me that the practical approach we were taking was correct and that we could develop this throughout the school to support beyond fluency and application into explanation and reasoning; ensuring different teaching strategies would work side by side, developing fluency and deeper understanding.

We introduced a bank of high-quality activities to support rapid recall, some with conceptual support and some without, for example, reminding staff about counting sticks, using pendulum counters, whisper counting, 2, **4**, 6, **8** – activities which include both step counting and full verbal patterning (saying and hearing the sound of the pattern phrase to support verbal memory). We put in a bulk order of beach balls for throwing, catching and keepy-uppie games. This is one of the children's favourite activities and they always mention it when their pupil voice is heard. We also decided as an education

trust on a cohesive order in which each year group would teach the times tables.

Discussions as part of another Mastery Readiness Hub at the time led us to decide that we would include the EYFS in the project. This was by them focusing on subitizing and understanding of number using Number Blocks and the ten frame in readiness for counting in Year 1. Following on from the CPD sessions we also agreed that arrays made from interlocking cubes would be the main concrete apparatus to support children in their learning. Within my year group we also made array sliders, a resource invented by our tutor Jenny Field, which the children loved using; in one lesson I saw a child improvise by using their whiteboard to slide over an array they had made out of cubes to explain their answer to their partner.

We have a consistent framework for weekly times tables across the school as well as a manageable system to assess the children's progress via online assessments by class or child; teachers and pupils are able to see the multiplication facts they need to still work on. There is an excitement around times tables in school now, which gives me hope and encouragement for the future.

The start of each new half term is the start of a new times table and the children look forward to drawing pictorial representations and finding images for their times tables displays. Times tables are also taught as a mental starter on a regular basis, maintaining the children's fluency. Maths lessons on the *focus* times tables are more exploratory and the children are beginning to develop their explanation and reasoning. This will continue to develop as we continue to embed this approach. A new cohort of staff from the trust are attending the project this year, and they are already coming back with ideas to use within their own classrooms. We are now looking at ways in which we can track the progress of the impact of the project, both through the pupils' responses and enthusiasm, also through the assessment information we are gathering.

A highlight for me is watching children take charge of the counting stick and using it as the class teacher, demonstrating how well they understand the different times tables. One Year 2 child was asked to use the counting stick when we were learning about fractions and then declared '*So 10 x ½ is the same as saying ½ of 10, 4 x ½ is the same as saying half of 4?*' – neural pathways were certainly forged that day not only for her, but for others around her who chorused '*Oh, yeah, she's right!*'. They then went off with their cubes and whiteboards to see if that was always the case.

As a school we will continue to develop our teaching of multiplication tables, keeping a focus both on fluency and on explanation and reasoning for that deeper understanding. Keeping the lessons fun and engaging with the right amount of edge and challenge. In this way we will continue to keep learning fresh and engaging for staff and children alike. Times tables can also be part of our inter-community challenges within houses alongside the usual sporting and artistic inter-house competitions.

Overall, the project has been a useful start to improving the teaching and understanding of times tables within our school. A strong starting point from which we can develop and grow as a school community, enabling staff to develop their subject knowledge and understanding of misconceptions meaning they are able to design more successful lessons to enable children to become fluent 'masters' of their times tables. We are looking forward to the results this year – if it was based on enthusiasm, we are certainly on track for a successful outcome!

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