Reaching the Standard in Mathematics at KS2:
Improving outcomes in mathematics at district level:

The Starting Point:
Too many pupils in one district in Hampshire in 2017 were close to reaching the expected standard in mathematics at the end of KS2, but did not quite make it.

Six schools visited were visited to establish whether there were any common issues around 'close-to' pupils in mathematics. In each school, the headteacher, maths subject leader and teachers of Year 6 met with the HIAS inspector advisor to review data for the 2017 cohort, pupils' work and the 2017 question level analysis. Pupil interviews were also conducted. In most cases, schools had identified issues and were taking steps to address them. Question level analysis in some schools showed specific areas of weakness, predominantly fractions, whilst others showed no trends that could inform future curriculum planning.

The Issues:
The following areas were found to be common to the majority of schools taking part in the enquiry.

- Teachers felt pressured to deliver end of year expectations in Y6 and defaulted to teaching in a procedural way. This was often qualified with pupils having had a 'poor year' somewhere within their primary journey due to weak teaching. Teachers believed that the gaps in knowledge exhibited by pupils could only be addressed with short term fixes (learn the procedure) by the time they arrived in Year 6.
- In some cases, lower attaining pupils were expected to work at end of year expectations during the autumn term. This led to confusion for the pupils when asked to apply their knowledge to non-routine problems. This was seen in both mixed attainment classes and in ability sets.
- Inaccurate teacher assessment that did not match the test outcomes. Where this was the case, books were reviewed. It was found that tests were often a feature of ongoing teacher assessment and evidence of formative assessment in the form of short tasks or annotated pupil work was minimal. In a small number of cases, the school had been following a scheme or testing regime, which was seen as contributing to inaccurate SATs predictions.
- A lack of breadth and depth was evident in a significant number of books. These books were often characterised by a large number of calculations with little exploration or diagrammatic representations to expose structure. This could be due to some missing subject knowledge on the part of the teachers.
- Where there was more than one class in a cohort, a disparity in quality of teaching was sometimes a feature. Pupils in one class did less well, on average, than their peers.
- Silo teaching: It was noted that the Y6 curriculum was often delivered in silos. Teachers reacted to the end of year objectives and delivered them individually, rather than making rich connections across mathematics. This led to 'close-to' pupils failing to see links. Consequently, they were unable to be flexible and show fluency in the SATs test. This is linked to procedural teaching.
- Pupil diagnostic interviews revealed 'close-to' children (in the current Y6) lacked fluency and breadth of strategies. They consistently failed to make connections when asked to 'show me 12' and quickly ran out of ideas.
- Arithmetic paper analysis identified place value, fractions and times-tables as the problem areas for last year's cohort. All error analysis pointed to a lack of understanding of multiplicative relationships with too much drill and practice and insufficient insightful models and images.
- Books showed that the CPA approach (concrete, pictorial, abstract) was often presented in a hierarchical way. This meant that the concrete representations had become burdensome,

rather than revealing structure to enable reasoning. Reasoning was limited to 'explain what you did' type comments, leading to prolonged written descriptions of what they did from pupils (procedural list).

- Some marking and feedback policies in schools were ineffective (e.g. two stars and a wish was over-used and lacked impact). When teachers gave written feedback that included challenging questions, pupils who did not reach the standard often did not appear to have responded or reacted. There was a sense that marking was 'done' rather than seeing feedback as a learning dialogue between teacher and pupil. For close-to pupils, the impact of such marking appeared to be minimal on the next steps in learning.

The Fixes:

How do we achieve success and access for all?

Reviewing best practice in schools with a high percentage of pupils achieving ARE, alongside current research, the following suggested actions are offered for consideration:

Assessment, marking and feedback, including questioning:

- Use assessment to build on pupils' existing knowledge and understanding. Teachers may need to try a different approach if what they did first time did not work. This assessment is not formal but is formative and 'organic', in that it is a direct response to what pupils are doing in the lesson.
- Use assessment of pupils' strengths and weaknesses to inform selection and use of tasks. Tasks and resources are tools which need to be deployed effectively to have a positive impact on learning.
- If a pupil has not understood the concept in the lesson, same day interventions should be a regular feature of the child's learning journey. A different approach, model or image is likely to be required. Interventions need to be short sessions that enable pupils to be ready for the next lesson so that all can keep up.
- Offer same day, in class, feedback. Effective feedback and responses will enable teachers to have an intimate and immediate insight into what pupils know and understand. Written feedback at point of instruction should add value to a learning conversation and has more impact and value than summative, end of day, marking. Always model responses for pupils to show them how to respond. Schools should be careful to avoid onerous marking policies that detract from adding value to the learning conversation between teacher and pupil.
- Address misconceptions immediately. A misconception is an understanding that leads to a 'systematic pattern of errors'. For example, multiplying by 10 can be done quickly by adding a zero (is this true for 0.5 x 10?). Teacher subject knowledge needs to be sufficiently robust to ensure that common misconceptions are planned for and are not sidestepped or ignored.
- Do the mathematics! Whenever a lesson is planned, or a task designed, teachers should rehearse the mathematics to ensure that it works and that they understand the mathematical structure that underpins their lesson content. This preparation will enable teachers to use time in lessons that was previously spent checking answers or creating a new challenge for the 'speedy' pupil to ask insightful questions. Questioning in mathematics needs to start a learning conversation.

The use of manipulatives and different representations

- Teachers should appreciate that manipulatives and representations are tools that reveal structure. They should have a clear rationale for their choice of representation to teach a specific mathematical concept.
- Manipulatives should be used to provide insights into increasingly sophisticated mathematics. Teachers should enable pupils to see links between the resource and the ideas that they represent.

- Use a number line. Evidence indicates that number lines are a particularly effective representation for a wide range of ideas in mathematics.
- Use arrays (open and closed). The use of diagrams that reveal structure support pupils to make links across multiplicative relationships and also to model the laws of arithmetic (commutative, associative and distributive).

Problem Solving

- Teach pupils strategies for problem solving. These are general strategies that can be applied to solving a variety of different problems such as *identify a simpler problem first, make a table/ be systematic* or *trial and improvement.*
- Organise teaching so that problems with *similar* structures and *different* contexts are presented together to allow pupils to develop strategies and recognise types of problems.
- Encourage pupils to use visual representations. Help pupils make use of appropriate diagrams to provide insight into the structure of a problem (bar models are a good example here).
- Develop evaluative thinking. Expect pupils to ask questions such as, "What am I trying to work out?", "How am I going to go about it?", "Have I seen a problem like this one before?" and "What approaches could I try?"

Mathematical Networks:

- Teaching should always emphasise the many connections between different mathematical facts, procedures and concepts.
- Planning should include an element of brainstorming to ensure that teachers are able to see the rich mathematical connections before teaching. For example, doubling and halving is linked to other multiples, factors and fractions. Fluency with doubling and halving enables access to other multiplication and associated division facts.
- Ensure that pupils develop fluent recall of number facts by making connections with other areas of mathematics. Time spent on multiple representations and images enables pupils with a range of learning preferences to commit number facts to long term memory.
- Ensure that pupils know and understand that fractions and decimals extend the number system beyond whole numbers. Exploring the idea of 'part / whole' for calculations and for discrete numbers should be a continual part of the mathematical experience for all pupils.
- Teach pupils to understand procedures. For example the decomposition method of subtraction is only possible if one can partition numbers in different ways and appreciate that "one of these is worth ten of these". For many pupils, it is best understood by modelling the calculation with base ten materials.

Independence and Motivation:

- Support pupils to develop metacognition (the ability to independently plan, monitor and evaluate their own thinking and learning). This is **not** smiley faces against predetermined success criteria. It can be done through encouraging pupils to explain their thinking to other pupils and through providing appropriate models and images to facilitate that evaluative thinking. Pupils should be encouraged to ask themselves whether or not their answer makes sense, could they show it in a different way, do they know good strategy to try , have they seen a problem like this one before and so on.
- Collaborative working. Pupil independence is developed when they feel safe to learn. This is often when working in pairs or small groups to agree a solution or strategy. Pupils will need teachers to model effective discussion and dialogue.
- Give pupils time. Regardless of the concept being taught, pupils need significant time to imitate, internalise and independently apply strategies. **Fewer things in greater depth.**

- **Teachers should behave like mathematicians**. Placing value on the subject, its rich connections and processes changes attitudes. A 'can do', growth mind-set approach opens up new possibilities for a learner.

Interventions:

- Use **structured** interventions to provide additional support. These should happen early to reduce pupil's anxiety and ensure that misconceptions do not become entrenched.
- Interventions should include explicit and systematic teaching. If this is not delivered by a teacher, then it should be planned and monitored by the teacher.
- Ensure that connections are made between any intervention and whole-class instruction. Interventions should work alongside the main lesson.
- Interventions should motivate pupils. They must add value to learning so that the pupil feels supported and able to return to the main group.

In summary:

The recommendations made in this document are not intended to be a 'fix-all'. Schools should select areas to work on as required, some of which are listed here. It is a well-known adage that if we want to change something, we should do something differently. The same is true of teaching and learning in mathematics. As teachers of mathematics, we should always ask ourselves the question, "How do we ensure access and success for all?". This is turn should encourage the planning, rehearsing and teaching of a wide range of carefully considered approaches that pays due attention to the many different learning preferences in our classrooms. The idea of fewer things in greater depth to encourage metacognition, leading to independence and motivation is a key factor for many pupils. It is hoped that this document provides some ideas and starting points for professional dialogue in schools. In addition to this, it is hoped that it supports the development of consistently excellent, well-thought through maths teaching that creates positive experiences and excellent outcomes for all pupils at the end of KS2.

References:

Improving Reasoning: Analysing Alternative Approaches: Malcolm Swan
Big Ideas in Primary Maths: Mike Askew
'You Cubed': Changing Mathematical Mindsets: Jo Boaler
Improving Mathematics in Key Stages Two and Three: Education Endowment Foundation(2017)
Key understandings in mathematics learning: Nunes, Bryant, Watson (2009)