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Key stages	KS2
School type	LA maintained, primary
Themes	Mathematics

Will developing the CPA approach for high attaining children with a fixed mindset increase resilience, accuracy, understanding and thinking?

St Thomas More Catholic Primary School

Context

St Thomas More Catholic Primary School is an average-sized primary school which serves Catholic parishes in Berkhamsted, Tring and the surrounding rural areas located in the Dacorum district of Hertfordshire. The school was rated as 'outstanding' by Ofsted in 2009.

The focus

On Friday 18th September 2015, the Herts for Learning maths team hosted a national conference with Jo Boaler, Professor of Mathematics at Stanford University, as the key note speaker. Many Hertfordshire teachers attended the conference to find out more about developing mathematical mindsets and were inspired to continue improving opportunities in mathematics for their pupils through an action research project. The purpose of the project was to explore some of the themes covered by Jo Boaler and research different ways of developing mathematical mindsets. ***This case study has been written by Fionnuala Smith, Deputy Head and Maths Lead at St Thomas More Catholic Primary School.***

The new curriculum (2015) prompted us to look at our delivery of mathematics and the resources we had available to support teaching. With the focus on mastery and fluency and resultant development of a more "low threshold, high ceiling" approach, we found that some high attaining children in Key Stage 1 were uncomfortable and reluctant to engage. Typically, this group wanted to do calculations and were reluctant or unable to apply their maths. They found it difficult to explain their answers; could not use manipulatives effectively; and typically could not recognise calculating errors.

Our school promotes a growth mindset, yet these children were displaying a fixed mindset that was limiting their progression in understanding and reasoning. Analysis shows that the highest-achieving students in the world are those with a growth mindset (*analysis of PISA 2012 in Mathmatical Mindsets)*. In order for higher attaining children at the end of Key Stage 1 to progress and develop as mathematicians, our focus is to develop their growth mindset to support their depth of Maths learning in a resilient, accurate and questioning manner.

Developing the children's use of concrete, pictorial and abstract approaches in a combined way was key to our focus. We investigated whether an increased requirement to explain and prove answers with the use of pictorial diagrams and concrete resources would develop previously high attaining pupils' ability to prove that their

calculations or problem solving was plausible or correct. In addition, we wanted them to value investigating mistakes; view maths as creative and open – rather than solely the ability to use formal written methods (their criteria for achievement). As Professor Jo Boaler says: "When we teach students that mistakes are positive, it has an incredibly liberating effect on them." We wanted to open their eyes and minds to the possibilities of maths.

Description of my approach

We carried out a pupil voice and survey on eight Year 3 pupils (Child 1-8) who had achieved Level 3 in Key Stage 1 and selected four we felt had the most fixed mindsets. The response from the four pupils was varied, but significant. Responses included:

- **Number lines** -*"Not really for me."* (C1); *"Not sure about diagrams".* (C3)
- **Times tables** – *"prefer just writing them out".* (C4)
- **How do you check?** – *"I think it"* (C2)*; "I would go over it again"* (C4)*; "don't normally check"* (C4). "*Don't like checking that much*." (C3).
- **How they feel when they get something wrong** – *"Annoyed. Just think the person is mean."* (C2)*; "When I get loads wrong it is embarrassing. I don't like making mistakes."* (C1)
- **What makes you feel good during Maths?** – *"when we just get sums and do them."* (C4)*; "doing sums; hate activities".* (C1)
- **Do you find Maths engaging / creative?** – *"don't enjoy when doing/using equipment"* (C2)*; wouldn't use mental maths if I can do sum"* (C4)*; "Hate activities, like doing sums"* (C1).

What we did

- In class, increased focus on proving answers in a variety of ways *(use of talk partners – using different ways to show and prove answer / switching roles; speaking frames).*
- Specific tasks (*group problem solving, explaining and then challenge of creating a problem – with diagrams – to present to class*). Use of exercise book with blank pages.
- In class, highlight benefit of mistakes – *brain growing; plasticity of brain; praise and appreciation.*
- Focus on fluency – *quizzes and review; how do you know? Can you prove it? How else could you show this? Morning activities on deriving facts e.g. four operations to derive facts for 40; If I know this, what else do I know?*
- Open tasks – pattern seeking; multiple answer questions.

Learners responses

Child 1 had the most fixed mindset and was reluctant to give up his perceived status as "the best in the class" at calculating. He still finds it difficult to deal with mistakes – "I feel gutted". He has consciously improved in explaining his answers. However, what did change was his enjoyment of maths. This can be put down to a growing willingness to try activities, which he previously would not engage in, and contribute in class discussion. His demeanour changed once he had made a contribution or a suggestion that was recognised by the teacher. It is possible that this child has relied too long on the process and has not developed a depth of understanding or engagement if the task has not been closed. Low threshold, high ceiling activities are enabling him to build understanding and depth of knowledge without exposing his lack of depth of understanding.

The two most successful approaches to increase resilience and investigation were clear tasks to prove answers in different ways with talk partners and switching roles; and creating problems (with diagrams) to present to the class. These tasks made them think through and clearly present the problem with the requirement to have pictorial representations. They found this challenging but they were motivated and it enabled them to develop a complete understanding of the process. They were able to highlight errors in their initial work. The approach also been beneficial and engaging for all of the class.

They could vocalise that mistakes are valued but their behaviour showed that they did not truly accept this. This was particularly evident with Child 1 and 2.

When pattern seeking or on open questions there was an initial reluctance to explore from two of the children. They wanted to achieve 'the' answer as quickly as possible. Other pupils' suggestions and varied approaches did support these pupils investigating further. Child 1 found this most difficult (C1 = one of highest achievers in test in Year 2). He wanted a set answer that he could reach quickly. So was frustrated at times and less flexible in his thinking. There was, however, a marked improvement and engagement over time from all four to contribute ideas, supported by the ideas coming from the rest of the class and they wanted to be part of that.

There was still a preference for "just doing sums" from two of the children (Child 1 and 4). This can be attributed to where they feel most confident. Child 2 initially put his strength as addition and subtraction. At the end of the study, he was clear his strength was problem solving, indicating an increased confidence in apply his maths. This is borne out in his work. Maths fluency sessions and varied speaking frames have supported both clarity of connections (i.e. I know 36 is a multiple of 9 because 9 x 4 = 36) and the ability to express maths using accurate vocabulary.

Widening the approach

The focus has been shared with Year 4 as there was good liaison with this teacher, who has embraced CPA approach. She has two high attaining pupils who have fixed mindsets and is using several similar approaches that will support the deepening of their learning. These two children have taken on more open challenges and tasks to show different ways of proving their answer. The teacher reports that they no longer try to finish task quickly (something that they had previously done to showcase their ability) and develop and prove answers much more effectively and with discussion.

Impact and recommendations

For the group, the most significant change, based on a pupil survey at the start and end of the research, was how positive and excited the children felt at the start of a maths lesson. In the initial survey the total for the four boys was 18 (out of 40) and the range 2-8. In the second survey the score was 39 (out of 40). As well as enjoyment, confidence in maths also rose from 30 to 35 (out of 40). All four children gave an increased rating out of 10 for their maths vocabulary.

Three of the four boys have a more positive attitude to using manipulatives and diagrams. But Child 1, in the second pupil voice, described using manipulatives as "cheating" and "stopping your brain". This prompted immediate disagreement from Child 3 who said "using Numicon shows your brain is working. It is not cheating, it helps you with your Maths."

These four pupils have increased their ability to explain and prove their answers. However, their judgements on their own ability is still rooted in their ability to calculate despite gaining enjoyment and achieving success in tasks with more depth and investigation. They have started to not equate success solely with a correct calculation. Child 3 could recognise that use of manipulatives and diagrams is challenging to the brain and helps your maths. The teacher's role is important in developing this through questioning, praise and openly valuing contributions.

This research is still at the developing and establishing stage. The approaches have been essential for the long term development of resilience, accuracy, understanding and thinking that will 'liberate' these pupils' learning in maths. To fully establish a deep-rooted growth mindset, the focus of achievement and praise for investigation and questioning through low threshold, high ceiling teaching needs to continue. The CPA approach firmly supports this.

Contact	**Fionnuala Smith, Deputy Head and Maths Lead at St Thomas More Catholic Primary School**
Reading and website references	**Boaler, J. (2015) *Mathematical Mindsets: Unleashing Students' Potential Through Creative Math, Inspiring Messages and Innovative Teaching*, John Wiley & Sons.** **Robinson, T. 2016 *Teaching for Mastery: The Underpinning Learning Theories* HfL Primary Teaching and Learning Maths Spring 2016 Newsletter** **Dacorum School Partnership Conference, April 28, 2016 – Emma Judge, Psychologist (Thrive) – *The "How To" of Resilience (ABC)*** **Weightman, R. 2016, *From Strong Foundations – Our Conceptual Approach to Teaching Number,* Putteridge Primary School** **School website: www.stmore.herts.sch.uk**

If you have an aspect of interesting practice that could be shared or are interested in finding out more about a case study please get in touch by emailing exchangingexcellence@hertsforlearning.co.uk

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