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Key stages	KS2
School type	LA maintained, primary
Themes	Mathematics

Providing pupils with opportunities to use concrete resources through ‘explore’ activities in order to develop the use of multiple representation when approaching maths work

St Cuthbert Mayne Catholic Junior School

Context

St Cuthbert Mayne Catholic Junior School is a primary school located in the Dacorum district of Hertfordshire. The school was rated as ‘good’ by Ofsted in November 2016.

The focus

On Friday 18th September 2015, the Herts for Learning (HfL) 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 Alexander Sallis, Class Teacher and Maths Subject Leader at St Cuthbert Mayne Catholic Junior School.*

Maths has been a whole school focus for the last two academic years as we have seen a dip in pupils making at least expected progress as well as those making accelerated progress. We hoped that the opportunity to take part in action research with the support of HfL and other participating schools would complement other work that we are undertaking with the aim of improving standards in maths across the school.

At the outset, we decided to focus on attitudes towards maths (specifically struggling mathematicians) through teaching mixed ability lessons, using low threshold/high ceiling tasks. I began by building learning objectives through the ‘Working Mathematically’ document created by HfL to support pupils to develop the necessary skills to feel confident about tackling mathematical tasks. After two lessons, outcomes were good with pupils responding positively.

However, following a review of progress towards our whole school maths action plan, I decided that a focus on the use of core manipulatives and the impact they would have on staff and pupils would be more symbiotic with our whole school aims.

Description of my approach

Throughout the year, I had been working with a teacher in Year 3 (in relation to another course run by HfL) on building a sequence of teaching for mastery that used 'explore' lessons, supported by manipulatives, at the beginning of each new unit of learning. In an article published for NRICH, Jenni Back asserts that learners need opportunities to *'make sense of both the manipulatives used and their relation to the mathematical ideas and problems which they are being use to solve'*. 'Explore' lessons, it was hoped, would provide this opportunity.

In the HfL Maths Spring 2016 Newsletter, the author describes the importance of teaching all stages of the 'Concrete, Pictorial, Abstract' (CPA) sequence to ensure that *'pupils are able to make good links between each stage'*. Explore activities developed by the teacher encouraged this as much as possible.

Work completed by pupils and feedback from the member of staff involved with the work supported the view that providing opportunities to use concrete resources in the context of an 'explore' lesson was leading to greater confidence, better engagement from pupils and better learning outcomes for pupils in her class as well as supporting her own CPD in mathematics teaching. Current end of year performance data, supported by feedback from the teacher provides evidence of the positive impact of this approach.

Widening the approach

In contrast to this, it became clear that pupils in other classes were not being given structured opportunities to use concrete resources when working on mathematics in class. This was predominantly due to the lack of availability of resources and resultant lack of staff skill.

The success of the work in Year 3 supported our decision to purchase resources for the whole school with each class receiving a set of core manipulatives including: base ten, bead strings, Numicon, Cuisenaire rods among other resources.

In order to replicate the progress made by the Year 3 class, I asked the Year 3 teacher who had piloted the 'explore' lesson approach to model (during a session at a staff meeting) two of the activities that she undertook with her class to provide a starting point for the rest of the staff group. Over half of the teachers present had not used concrete resources with their classes regularly in the current academic year. Following general discussions, staff paired with their year group partner and planned a lesson / sequence of lessons which allowed pupils to explore a suitable mathematical concept/area using any of the new resources.

The purpose of this was two-fold:

- to encourage staff to use the resources purchased
- to encourage pupils to think about different representations and deepen their understanding of the area of maths being explored

During this session, I also introduced a progress framework for developing the use of concrete resources in school in order to give staff clear expectations for future development.

Impact and recommendations

Following the introduction of this approach, most members of staff were excited about the impact of the ‘explore’ lesson they taught. Even after only one session, feedback highlighted the impact in terms of engagement, enjoyment and level of understanding. One teacher commented: *“They enjoyed being able to answer the sums through different representations.”* While several teachers reflected on the impact on their own practice: *“It made me realise how easy it is to use manipulatives to support and extend the learning of all children in my class – not just the least able.”*

Over the course of the time undertaking this research project, we made a significant change in focus in an attempt to combine aspects of our work to improve maths across the school. This resulted in a shorter time frame to plan, complete and measure the impact of the work completed. Consequently, we decided to build on previous work being undertaken and integrated it into this research project.

Outcomes in the Year 3 class clearly demonstrate that pupils became more confident at representing aspects of maths in different ways, and consequently became better equipped to solve problems. The most significant improvement was seen in pupils’ arithmetic work. The teacher believes this was as a result of pupils developing a deeper understanding of the what was happening when they were adding, subtracting, multiplying and dividing. Supporting this conclusion, recent meta-analysis cited by Jenni Back in her article, ‘Manipulatives in the Primary Classroom,’ found that learning outcomes were improved to a ‘moderate to large’ degree in the case of retention as a result of using manipulatives in teaching mathematics. One conclusion we could draw from this is that the pupils better remembered the processes required for their arithmetic work because they had the opportunity to ‘explore’ and consequently deepen their understanding throughout the learning sequence.

Outcomes for the other classes will not be known until the approach is embedded throughout the next academic year.

Despite limited quantitative data for years 4 through to 5, a number of important intended outcomes of this research were, I believe, met: all staff taught at least one lesson that provided an opportunity for their pupils to explore a concept through the use of concrete resources which resulted in increased engagement and greater confidence for teachers themselves.

It is, however, important to recognise other aspects which will have impacted on the success of the Year 3 class. For example, the level of commitment and competence from the Year 3 teacher involved was very high; she skilfully followed up ‘explore’ lessons and built subsequent lessons around the concepts learnt and explored, allowing additional opportunities to develop new skills such as through linked homework tasks. If the other year groups are to benefit in the same way, their teachers will also have to be consistent and holistic in their approach - and for this, ongoing support and sharing of good practice will be essential. Additionally, carefully targeted staff and pupil voice will be important if we are to monitor the approaches impact and make meaningful assessments of outcomes as a result of our work.

Next steps

Our next step as a school is to ensure that this work continues in the new academic year. In addition to our normal tracking of three APP pupils in each class, I will be requesting that we also engage them in pupil voice specifically around the use of core manipulatives in supporting different representations. We will also continue to track the Year 3 class involved in the trial research to monitor the effectiveness over a longer period of time, monitoring to what extent the pupils are using manipulatives to help them 'make sense of mathematics' (Back, J - Nrich). As indicated above, a comprehensive commitment to sharing good practice across the school through staff meetings, subject leader monitoring and lesson studies as well as developing the skills and confidence of teaching assistants, will also be undertaken, supported by the progress framework developed for the use of concrete resources in classes.

Contact	Alexander Sallis, Class Teacher and Maths Subject Leader at St Cuthbert Mayne Catholic Junior School
Reading and website references	<p>Back, Jenni 'Manipulatives in the Primary Classroom', http://nrich.maths.org/10461 University of Cambridge</p> <p>Boaler, Jo: Promoting 'relational equity' and high mathematics achievement through an innovative mixed ability approach <i>British Educational Research Journal</i> (2008) 34 (2), 167-194</p> <p>HfL Primary Teaching and Learning Maths Spring 2016 Newsletter: 'Teaching for Mastery: Underpinning Learning Theories The 'CPA' Approach, pp12-16</p> <p>HfL Primary Teaching and Learning Maths Spring 2016 Newsletter CPA: using Cuisenaire to support pupils to develop fractional understanding</p> <p>NAMA: Five Myths of Mastery in Mathematics December 2015</p> <p>Smith, C. (Ed.) Proceedings of the British Society for Research into Learning Mathematics 31(1) March 2011 <i>Children's perceptions of, and attitudes towards, their mathematics lessons</i></p> <p>School website: http://www.st-cuthbertmayne.co.uk/</p>

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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