



Date	March 2017
Key stages	KS1
School type	LA maintained, primary
Themes	Mathematics

How does the use of concrete manipulatives and visual props support the development of number fluency and number talk?

Wheatfields Infants' and Nursery School

Context

Wheatfields Infants' and Nursery School is a three form entry primary school located in the St Albans district of Hertfordshire. The school was rated as 'outstanding' by Ofsted in 2014.

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 Nadine Greening, Numbers Count Teacher- Maths co-ordinator/ Forest School Co-ordinator at Wheatfields Infants' and Nursery School.*

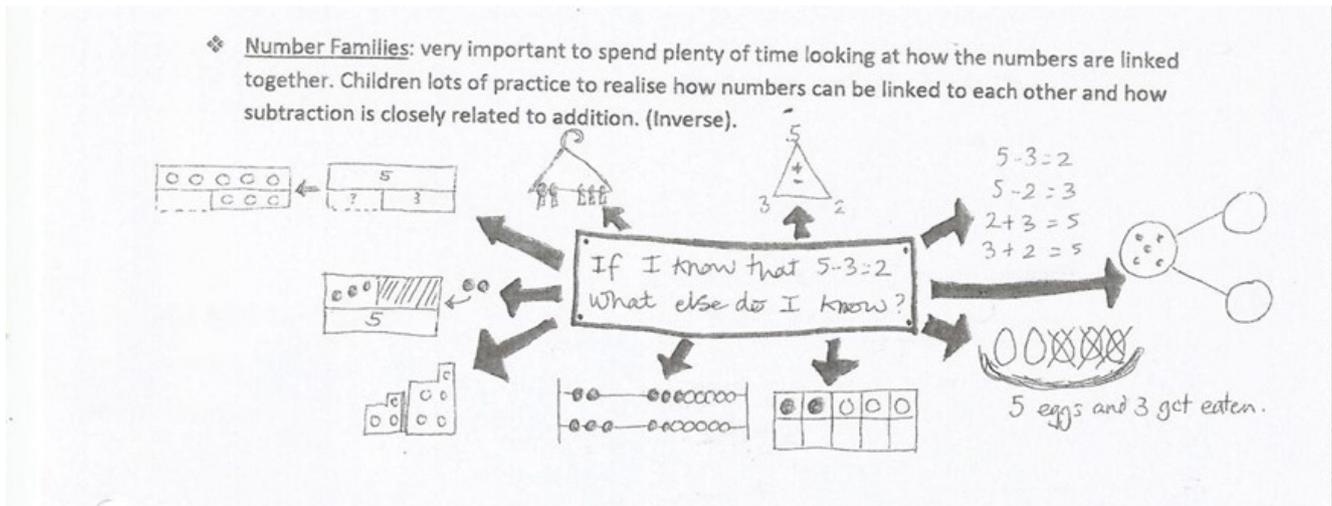
The classroom and book scrutiny (for the whole school) at the end of the autumn term in 2015 showed a lot of very abstract recorded work using only number sentences with very few drawings or different ways of showing how to solve a problem. There was very little evidence showing how the child worked it out other than with number sentences. There were no drawings, use of 10 frames, Dienes, partitioning circles etc. and little evidence of the children checking to see if their answer made sense, of using inverse or trying to find another way of proving their answer. There were also insufficient classroom props for children to use regularly as reference guides. (e.g. number lines, ten town number formation).

Description of my approach

Starting point for change

Four staff meetings were held over the course of the Autumn and Spring term. The first one introduced some of the Montessori equipment now in use from Nursery up to Year 2, the second one was specifically on the use of 5/10 frames, the third one covered how to teach early numeracy (and the need for different manipulatives and visual props to help solve a problem), and the last one focussed specifically on subtraction and ways of recording. This last meeting seemed to have the greatest impact, with 1 diagram (next page) in particular seeming to help many of the teachers to understand where next to focus.

Diagram 1



This information was then also passed on to all Learning Support Assistants (LSAs) and Higher Level Teaching Assistants (HLTAs) over a series of 30 minute meetings as well as being passed on to the school governors/parent governors.

Materials/ resources used

Five and tens frames, coat hangers and pegs, Numicon, Rekenreks, counters in partitioning circles, Dienes, Montessori Golden Beads, number family triangles, dot paper strips, Singapore bar method etc.

Learner's responses and changes over time

Teachers in Nursery, Reception, Year 1 and 2 now all use a much wider variety of ways to record an answer. The children enjoy being able to record their findings without always having to write a number sentence to prove it. Teachers in Reception and Year 1 have now got lots of photocopied small pre-cut visual models which children can use to demonstrate how they solved a problem (Year 2 is also doing this but are waiting till next year to fully embed this). Rekenreks were very popular after maths week and seemed very useful both in consolidating '5' and '10' as anchor numbers and helping children to gain fluency in composing and decomposing different amounts. Subsequently, abacuses to 100 are starting to be made in the Year 2 classes and the excitement at being able to manipulate and see 100 beads is very tangible. Young children seem to really benefit from being able to touch and see amounts!

Widening the approach

Having started with a whole school focus in maths week and everyone now having had some experience with different manipulatives or visual props, it was decided to continue with another whole school focus. Staff divided into 3 groups and planned 3 separate lesson study sessions for Reception, Year 1 and Year 2

How did your research evolve when working with another colleague/s?

Reception pupils' lesson study showed that the children (when supported in the context of a group session), were already familiar with the concept of decomposing numbers on a partitioning circle and as soon as the missing number problem was put into the context of a story, had no problems in working out the missing number. By looking at how many beads they could see (on the top line of the Rekenrek), most could work out how many were missing. A lot more number talk arose from the use of this manipulative as well as conversations about inverse. However the children found it very hard to understand how the answer could be at the start of a number sentence and this will definitely need to be explored a lot earlier on in the next academic year, as well as regularly using weighing scales to introduce the concept of = to mean 'is the same as'. Additionally, from September, each teacher will try to keep a record of each child's number fluency for numbers from 3-10 so as to become fluent both in knowing all the ways an amount is composed of and then how it can be decomposed.

The lesson study carried out in Year 1 showed the need for the choice of resources to be limited to just one or two resources, as some of the children weren't quite ready to make their own decisions as to which would be the most appropriate resource (e.g. using a Rekenrek to solve a problem such as $15 + 7 = \dots$ when the Rekenrek only has 20 beads). Year 1 have now also undertaken some useful work in making class posters showing different children's favourite resource when solving particular problems.

Year 2 pupil's lesson study of introducing a new model (Singapore Bar Model) seemed to confuse a lot of the mathematically more able children, whilst actually helping the mathematically less able children. It did highlight the fact that although the children had been introduced to the concept of inverse (number family triangles) this concept didn't seem to be very deeply understood. The problem of ' $\square - 3 = 8$ ' had many children confused. Many said '5' was the missing number and found it hard to know what the biggest number was. Consequently we need to focus a lot more on: '*Does your answer make sense? How can you prove it? Can you show me another way of working it out?*' and possibly think about a different approach when recording work in maths books where after each solution the child has to then use another method (or the inverse) to check his/her answer.

Impact and recommendations

Since the last staff meeting on subtraction and then Maths Week, many of the Reception and Year 1 classes now feel like they're buzzing with maths ideas. There's a general sense of excitement and talk and exploration of number using lots of different manipulatives and visual resources.

Since their introduction in Maths Week, the Rekenreks seem to have very quickly become a favourite prop for many children. This resource, (alongside Numicon) was included in 7 out of 12 drawings completed in the drawing interviews with children from Reception up to Year 2.

It would seem that the Rekenreks are supporting number fluency in that children seem to notice very quickly that "if I know that there are 5 red beads and 5 white beads (and that 5 and 5 makes 10) then I know that if your hand is covering some of the beads and I can see 8 more on the pipe cleaner, then I know that 2 beads are being hidden. $8+2=10$." This understanding of composition and decomposition and inverse appears to be equally present with the 5/10 frames as well as the coat hangers, the partitioning circles and the Singapore bar model. In this sense 'Number talk' has certainly become a lot richer with children wanting to explain how they worked it out. Additionally, staff now seem to be more aware of the importance of number fluency and the need to use the hiding technique as a means of assessing it.

However, the evidence from the drawing interviews with children (from Reception to Year 2) highlighted the fact that only the youngest children drew pictures of themselves with others as ‘a way of helping them with their maths’. They said whilst drawing: “My learning partner helps me” and “we need to work together”, whereas none of the Year 1 or Year 2 children mentioned talking to others as a way of helping themselves with their maths. Number talk will still need plenty of encouragement in order to be seen as a possible (useful) method of solving a problem.

The concept of inverse is now further supported in many of the ‘Morning Maths Challenges’ which now include a lot of ‘prove it’ and ‘can you solve it another way?’

Following on from all the CPD, staff also seem to have become a lot more aware of the need to move slowly from ‘Concrete to Pictorial to Abstract’ and that the concrete and visual aspect of number needs to be present for a good while (if not always).

It is felt by various staff members that concrete manipulatives and visual props definitely support the development of number fluency and number talk but that these need to be introduced gradually and be used a lot before children can begin to choose them for themselves (and be able to use them independently). Hence lots of modelling and guidance early on as to which resource to use and plenty of conversations as to why it might be a helpful resource. This is evident in the posters now up in Year 1 classes showing photos of different children’s favourite ways of solving addition or subtraction.

Further work will now need to be done to update Wheatfields Infants’ and Nursery school Written Calculation Policy.

Contact	Nadine Greening, Numbers Count Teacher- Maths co-ordinator/ Forest School Co-ordinator at Wheatfields Infants' and Nursery School
Reading and website references	<p>Blanke, B., (2008), <i>Using the Rekenrek as a Visual Model for Strategic Reasoning in Mathematics</i>, The Learning Center, Oregon.</p> <p>Boaler, J., (2009) <i>The Elephant in the Classroom</i>. London: Souvenir Press.</p> <p>Borthwick, A., (March 2011), <i>Children's Perceptions of, and Attitudes towards, their Mathematics Lessons in</i> Smith, C (Ed), <i>Proceedings of the British Society for Research into Learning Mathematics</i>, p. 37-42.</p> <p>Boucher, D., <i>What's my number? Differentiating in K-1</i>, Math Coach's Corner</p> <p>Chinn, S., <i>The Fear of Maths- How to Overcome It- Sum Hope</i>, (2011), Souvenir Press, London.</p> <p>HFL Newsletter, (autumn term 2016), <i>Teaching for Mastery: Underpinning Learning Theories. The CPA Approach</i>.</p> <p>Shumway, J., (2011), <i>Number Sense Routines- Building Numerical Literacy Every Day in Grades K-3</i>, Stenhouse Publishers, Maine.</p> <p>Van de Walle, J., Lovin, L., Karp, K., Bay-Williams, J., (2014) <i>Teaching Student-Centered Mathematics</i>, Pearson, New Jersey.</p> <p><i>Websites:</i></p> <p>National Council of Teachers of Mathematics: www.nctm.org NRICH: www.nrich.maths.org School website: www.wheatfieldsinfants.herts.sch.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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