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Key stages	KS2
School type	LA maintained, primary
Themes	Mathematics

Does a pictorial approach in mathematics help low attaining children to ‘have a go’ at it?

Highwood Primary School

Context

Highwood Primary School is an average-sized school located in the Hertsmere district of Hertfordshire. The school was rated ‘good’ by Ofsted in 2013.

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 Jamie Marshall, Teacher & School Research Leader at Highwood Primary School.*

The school I teach at has recently undergone a lot of change. In the past three years or so, we have moved into a new building; the last head teacher retired after a long period at the school; there has been a significant movement in the number of new staff; and a new head teacher has started their role. Since this, the school has gone from an Ofsted grading of ‘requires improvement’ to a grading of ‘good’, and currently the school is aiming for Ofsted to appear within the next year and for it to result in a grading of ‘Excellent’.

One of the school’s current priority plans is to raise mathematics achievement for all children and specifically for less able children. These less able children need to reach age-related expectations by the end of Key Stage 2. Consequently, the school is now embracing new ideas, such as: using manipulatives across the school; INSETs led by mathematics specialists; changing of planning to make maths more open ended; and an investigative approach.

As research leader, my role within the school is to ensure that I keep up to date with current educational research. The research also tied in with many ideas that I have picked up from the Mathematics Conference, in October and the Mathematics Specialist Teacher (MAST) course run by the University of Hertfordshire that I am attending. I have always found that less able children appear to often ‘freeze’ at the beginning of an investigation and that they do not know where to start. After trying to implement a growth mindset in my classroom this year, I thought that there might be another reason behind this affect. Therefore, as most children are often very visual, I wanted to see if drawing a problem might enable children to get started.

Research approach

Due to our school priority of helping low attaining children, I decided to concentrate on these children. Initially, I asked my whole Year 6 class a few questions to see if any children really stood out as not enjoying investigations and struggling with how to start. The answers on the whole were very positive because I have undertaken some work with my class on this before due to influences from my MAST course. Most were happy to learn from their mistakes and would use a pictorial approach to help them. A number of the low ability children did indicate that they would use a pictorial approach; however, in previous investigations, I had not seen any evidence of this. If this approach is successful, I hope to influence other teachers into using it more widely across the school. With regard to this, the other reason for my choice was that on mentioning this to a PPA cover teacher for my class, she had not thought that drawing pictures were 'allowed' in Year 6 maths! Clearly this approach needs to be passed down to other Key Stage 1 and 2 teachers. One girl said, "I feel scared about making mistakes." The same girl also mentioned, column and grid method as strategies to use but did not mention a drawing. Another said she would kick herself if she made a mistake, but would draw little diagrams to help. These children became my focus group.

Observations

As writing answers to a questionnaire can be quite limiting, I decided to then interview the children in small groups to see if I could find out any more reasons as to why they might struggle initially in an investigation. They were all able to recall seeing someone model to them how to represent their ideas using drawings at the beginning of an investigation. So, although they hadn't mentioned the strategy initially they could recall having seen it being used by a teacher. They were all very positive about the approach: "It helps you to understand" and "It helps you to understand what fraction is being shown."

Currently, as a Year 6 class we are in class groups; however, before SATs the children were in two 'sets'. In the previous term, the children were split into three sets. All of my focus children were from the bottom 'set'. Since I the start of this project, we are in class groups and the children sit with their 'talk partner' during mathematics lessons (this is a randomly chosen pair at the start of each week, they could be two high achieving children, or a different mixture).

As Year 6 have completed their SATs, the aim of our mathematics lessons are purely investigative. We have given them a series of different investigations to complete, some of which have stretched out into more than one lesson! During these sessions, I have worked with my focus children modelling using a pictorial approach to help understand an investigation.

Our first investigation involved visualising how many painted faces a combination of cubes would have. All the focus children were able to access this by representing the faces in their books as squares. Some went on to write a number in the square as to how many faces could be seen. This strategy was one that other children in the class came up with in the initial discussion. One girl wrote a comment in her book at the end that, "This was tricky." However, all children were able to access the investigation. This investigation was a 'low-entry, high-ceiling' one, which enabled the children to all access it.

Our next investigation involved looking at a sequence of pictures, which were similar to trees. Again, the focus children were able to discover patterns within the pictures by drawing the sequence. One girl used this technique and wrote a clear explanation of what was happening. However, she RAGed (in our school the children write Red R, Amber A or Green G to show their understanding of the learning objective) her work as R and that she worked with a partner. Therefore, even though she used the pictorial technique to understand the investigation she felt at the end of the lesson that she did not understand.

As a starter to a mathematics lesson, I asked the children to show me how they would represent certain simple worded problems without using any mathematical symbols. Initially, some of these children struggled with this idea. But in the end, they used shapes, crossing out and recognisable drawings to show what was happening.

The next investigation involved finding out how many combinations of three beads you could fit into different numbers of bags. From the children's drawings you can see that they are starting to become more ordered in their layout: a child has drawn a clear box around each number of bags so it is easy to follow. Another child has recognised that drawing a picture is a valid method, "...my method was to draw out how many bags there are and then sort out the beads." A really low achieving child was able to explain, next to each of his drawings, his thought process at that stage in the investigation, "...one way only in one bag. I found three ways for the second bag."

As the project is coming to an end for the moment, I thought it would be interesting to see how these focus children got on with a task when isolated from other members of the class and a teacher's input! Would they use a pictorial approach to start solving the investigation?

Impact and recommendations

With the eight pupils, we began an investigation by reading through the question together and I explained (having found out from doing this investigation with another group of children before) what the phrase, 'and at the same minutes past each hour until...' means. Also, I reminded them of all the mathematical 'chats' we had had in previous investigation lessons about how to approach a problem and then the children got started. Most of the children chose instantly to work in pairs apart from one girl and one boy. A lot of the children like to use the RUCSAC (read/underline/choose/solve/answer/check) technique when looking at a worded problem as it has been taught to them a lot lower down the school. You can see in the children's work that they have underlined what they think are important words in the question. However, having observed them, this does not appear to help in the least.

Some of the children's first approach was to copy out the bus timetable. Once one person had done this, a number of other children also did it. After 10 minutes or so, all children had made a start at the problem but were stuck. Therefore, I kept asking them what they could do to help themselves hoping that they would say draw a picture. After a long drawn out conversation, including a lot of, 'What do you mean?', 'How can I see it?' type comments, one girl thought to draw a picture of a bus. She drew it as a rectangle, so clearly had remembered that the type of drawing doesn't matter and from that moment on she started to understand the problem. She drew other buses at the time that they finished and so on. Other children were then interested in what she was doing and started to try and do something similar.

The impact on learners can be measured via:

- **Increased confidence:** all the children were able to attempt a start to the investigation.
- **Increased perseverance:** all the children were still trying to tackle the problem without any adult help after 10 minutes.
- **Increased talk:** most of the children, quite naturally, began to work out their investigation in pairs by talking through their ideas with the person who was sitting next to them.
- **Another strategy:** all the children were able to use the pictorial method to try and solve the investigation and, when they did, understood what was happening better than when they were not using it. The only issue being that they had to be prompted quite heavily to use this idea. This is the most disappointing aspect. I had carried a number of similar lessons beforehand using this idea and they did not think to use this approach naturally. It clearly needs more work or needs to be made more explicit.

Impact on researchers and the wider school community:

As a result of this project, I will be continuing to teach this pictorial approach to solving investigations in the future as I believe that it showed real promise for low achieving children especially. Having spoken to other members of staff, it appears that I need to think very carefully about how to pass on this information to the other teachers in the school so that children feel more comfortable at an earlier age in drawing out a problem in order to help them understand what is happening. I have found a number of different investigations aimed at Key Stage 1 which it would be interesting for teachers to have a go at doing with their children and show them this approach.

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Reading and website references	<p>Askew, M. (2013) Talk: The Key to mathematical understanding? In McAteer, M. (ed) 2013; 2012; <i>Improving Primary Mathematics Teaching And Learning</i>, McGraw-Hill Education, Maidenhead. pp. 152-167.</p> <p>Askew. (2010) It ain't (just) what you do: effective teachers of numeracy, Chapter 2, pp31- 44. In Thompson, Ian (2010) <i>Issues in teaching numeracy in schools</i>, McGraw-Hill Education, Berkshire.</p> <p>Askew, Brown, Rhodes, William, Johnson. (1997) 'Effective Teachers of Numeracy in Primary Schools: Teachers' Beliefs, Practices and Pupils' Learning'. King's College, University of London. Paper presented at the British Educational Research Association Annual Conference (September 11-14 1997: University of York).</p> <p>Boaler, J. (2009) <i>The Elephant in the Classroom: Helping Children Learn and Love Maths</i>, Souvenir Press, London.</p> <p>Piggott, J. (2008) Rich tasks and contexts. Available at http://nrich.maths.org/public/viewer.php?obj_id=5662&part</p> <p>School website: www.highwood.herts.sch.uk</p>

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