

Hertfordshire mathematics research project 2011-12:

Engaging and Motivating Pupils in Primary Mathematics

This report summarises the findings of a small scale research project into ways that schools can effectively engage and motivate pupils in primary mathematics. Successful schools considered the experience of learning mathematics from the pupils' perspective, innovating on common teaching techniques to optimise engagement and motivation. Teachers collaborated effectively within their own school and between schools to share ideas and strategies.

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Published: June 2012

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Executive summary

This summary report is aimed at primary school leaders and teachers. It outlines the focus areas, pilot studies and impact from the schools who participated in the research project. It makes suggestions which other schools and teachers might find useful if exploring similar areas.

Between September 2011 and April 2012, 20 Primary Schools from across Hertfordshire took part in a research project to explore 'Engaging and Motivating Pupils in Primary Mathematics'. The schools who took part were based around 3 geographical areas: St Albans & Harpenden, Welwyn & Hatfield and North Herts. There were 6 or 7 schools in each geographical area which formed clusters for meetings.

After initial cluster meetings to discuss the scope of the research project, schools chose their own focus areas based on areas of interest and their school data. There was wide variety in the themes explored, including: 'Real life' maths, topics and projects – using a contextualised approach to engage and motivate pupils; use of resources, models and images to engage pupils and increase confidence; and developing the use of questioning, reasoning, pupil talk and collaboration to motivate pupils in learning. A full summary of the focus areas can be found in section four, on page 9.

The research project was led by the Hertfordshire LA Primary Teaching and Learning Advisory team, drawing on support from six Mathematics Advisers.

Schools were asked to comment on the impact of their pilot study and make suggestions or recommendations based on their findings, which other schools and settings might find useful. Pupil voice, observations and data were used to measure impact in both qualitative and quantitative ways. All of the case study reports from schools have been made available on the Hertfordshire Grid for Learning website.

The Hertfordshire Teaching and Learning team would like to thank all of the schools and teachers who participated in the project and the advisers who supported the work.

Key findings

- All of the schools who participated in the project have reported that there has been impact on pupil enjoyment, engagement and confidence as a result of their pilot study. Many schools also reported impact directly on pupil achievement, or that they expect there to be a positive impact on data but at the point of the write up of their project it was too soon to measure.
- Schools were given the opportunity to decide their own focus area linked to the research project title: 'Engaging and Motivating Pupils in Primary Mathematics'. Focus areas covered a range of aspects of teaching and learning in mathematics;
 - o aspects of the learning experience, for example; real life maths, use of resources, investigations and games
 - o aspects of pedagogy, for example; talk, questioning learning styles, pupil choice and collaboration
 - o aspects of subject knowledge, for example; calculations, mental maths
 - o responding to data, for example; girls who are underachieving, gifted and talented pupils
- Some schools' pilot studies covered more than one focus area and so maybe discussed in more than one section below.
- Many schools found pupil interviews key to shaping their work. Pupils from a range of year groups articulated their feelings about maths (levels of enjoyment, areas of personal strength / weakness, learning style preferences). A number of schools used a rating scale (e.g. 1 - 8) for areas such as confidence and enjoyment, using this at both entry and exit points to measure progress and impact. Alongside school data analysis, this supported schools in developing an effective pilot study and measuring changes.

'Real life maths', topics and projects

- Six schools focused on making maths more purposeful through 'real life' projects, topics and investigations (e.g. carrying out market research for a company). The length of time spent on projects and investigations varied from one or two lessons up to two weeks of lessons. Teachers found that contextualising mathematics did increase motivation and engagement, particularly for pupils who might otherwise easily disengage. The length of time spent on the project did not necessarily affect enjoyment or engagement as all lengths of project had a positive impact.
- One school trialled the topic approach with Year 2 pupils, focusing of the engagement and enjoyment particularly of more able girls. The pilot group of 6 girls initially rated enjoyment of maths as an average of 5.3 out of 8 at the start of the project. Over the autumn term when mini topics were first trialled this went up to 6.9 out of 8. At the exit point in the spring this had further increased 7.2 out of 8. Some of the topics also had a cross curricular element, for example a project

linked to the Great Fire of London studied in history, using measuring in maths, for looking at recipes and baking bread. The class teacher also reported that she enjoyed teaching the maths more.

- Schools found that the main barriers to 'real life' projects, topics and investigations were; ensuring pupils had the skills needed to carry out tasks, differentiation for varying abilities and being able to assess progress in learning. Schools found creative ways to overcome these barriers such as devising pre-project assessment questions to assess skills and confidence levels which could then be repeated afterwards to measure progress.

Use of resources to support learning

- Three schools investigated aspects of the use of resources, models and images to support learning and engagement. One focused particularly on engaging more able pupils in lesson starter activities. Another school focused on using practical resources in upper Key Stage 2 to support pupils with gaps and misconceptions in their understanding. A third school investigated the impact of Numicon¹ on pupil engagement and motivation with Key Stage 1 pupils. The common finding from all three was that practical resources deepened pupils' understanding of mathematical concepts as well as increasing their motivation and engagement.
- One school focused on the use of games and resources in the mental and oral starter to the mathematics lesson to engage and motivate more able pupils for example throwing bean bags to create scores. These also involved greater use of open questions by the teacher, problem solving and pupil talk. Focus groups of pupils in Year 3 and Year 4 were interviewed at the entry and exit point about their enjoyment of mathematics. In Year 3, the average score increased from 6 to 6.5 out of 8. In Year 4, the average score increased from 6.25 to 7 out of 8. Both groups talked enthusiastically about the games they had been playing as part of their learning in maths.
- Another school also focused on the use of resources, but this time to target the learning of Year 6 pupils working at Level 3 in maths, with misconceptions and gaps in their understandings. The teacher used a range of resources, models and images to explore areas of maths, tracking back to a concrete point in teaching and then building back up to an abstract level or mental method quickly. Pupils were directly taught the possible uses of a range of resources and explored how each could support thinking and problem solving. Pupils were then given the opportunity to select which they found most beneficial. One indicator of success and impact was that the mental maths scores of the target group of pupils increased by 25% over the two terms of the pilot study.
- Numicon was used by one school to target lower attaining pupils in Key Stage 1 in maths, to increase their motivation and engagement. The Numicon had a significant impact on the children's concept of number and properties of number e.g. number bonds, odd and even numbers and repeated addition (leading into

¹ Numicon is a set of resources which represent numbers and supports understanding of number concepts and relationships, designed to support Quality First Teaching. They are produced by OUP.

multiplication). All pupils in the pilot study made progress in maths that the teacher was pleased with, she also noted an unintended positive impact on the pupils' independent learning.

Developing the use of questioning, reasoning, pupil talk and collaboration

- Four schools within the research project focused on aspects of questioning, talk, reasoning and pupil collaboration. All of the schools found that providing and scaffolding plenty of opportunities for pupil talk was key to pupils being able to think through the mathematics, explain their understanding and develop their confident use of mathematical language and vocabulary.
- Where pupils were encouraged to use peer learning opportunities such as talk partners, the teachers found that the learning experience for all pupils was improved. For example where a higher attaining pupil was paired with a lower attaining pupil the pairing could still be highly valuable as a peer learning experience with the higher attaining pupil articulating their thinking to support the development of the lower attaining pupil.
- Where language was the focus for one school, the pilot study focused upon displaying key vocabulary, which was explicitly modelled by adults and used within pupil talk e.g. talk partners. Prior to the project, many children had struggled to explain their maths using the correct language. Through pupil voice, the percentage of pupils who described themselves as confidently able to use mathematical language increased from 43% at the baseline, to 84% at the exit interview. This significant increase was supported by observations of the pupils, both in the language they used and in how confidently they participated in maths lessons, for example in class discussions.
- One school focused on questioning, active learning and pupil talk in maths. Their focus group of pupils were pupils attaining just below age related expectations. Within the pilot study, the teachers targeted questions towards the focus pupils and over time found that this improved the listening skills of those target pupils. Some pupils came to 'look forward' to being asked questions, showing greater engagement in lessons.

Mental and written calculation strategies

- Two schools began with analysis of assessment activities to identify areas of mathematics in which pupils were less confident. One school identified mental maths skills; the other school identified application of subtraction and division strategies to solving problems. Children's confidence in applying mental and written calculation strategies to problem solving are common areas to develop in many schools. Both of these schools found that clear modelling and rehearsal of language was essential. Pupils who had a better grasp of the language and vocabulary were better able to talk through (and think through) the problem and then apply their mental and written calculation skills.

- The school that focused on the teaching of mental maths skills dedicated a weekly session to this, supported by focused homework tasks. The teacher found that teaching fewer mental strategies but in greater depth increased pupils' understanding. Time was dedicated to children talking through the strategies they used, which impacted positively on their mathematical vocabulary. The attention to mental strategies led to an increase in pupil confidence in maths overall (measured by pupil voice) and also impacted upon their understanding and use of mathematical language when explaining their thinking.
- Where the teaching of subtraction strategies was the focus, the school motivated children through the context for the learning; using video clips of animals as a stimulus, followed by discussion about comparing sizes and weights (which would involve applying subtraction strategies). As a result of learning and using the strategies within a context, pupils improved their ability to apply the strategies to other problem solving contexts.

Increasing the confidence, attainment and progress of girls

- Two schools that focused on girls' confidence and achievement in maths found that guided maths teaching and a 'Girls Maths Club' led to increased confidence and also impacted positively on progress. In one of these schools the girls also engaged with topics and projects in maths and enjoyed having a context for the learning. The teacher reported that many of the focus girls now contribute more readily in maths in whole class situations, since the pilot study work.
- The school which used a 'Girls Maths Club' to support five girls identified as lacking in confidence and/or underachieving in mathematics in Year 4 (September 2011), developed practical, informal and talk based approach, for example playing maths games. They found that as a result of the club sessions, run weekly for 30 – 45 minutes, the girls' perception of their own confidence increased from an average 4 out of 8, to 5.9 out of 8. Four of the five girls also made 2 national curriculum sub levels progress over the 2 terms. This represented accelerated progress.

Building resourcefulness in pupils and 'pupil choice'

- Two schools investigated building pupils' resourcefulness: one with direct reference to Guy Claxton's 'Learning without Limits'; and the other focusing on pupil choice within differentiation. The 'Learning without Limits' approach highlighted the importance of giving pupils opportunities to collaborate, make choices and discuss ideas. In the school which looked at pupil choice within differentiation (focused on Key Stage 1 pupils), the teacher found that pupils were more motivated and engaged when selecting their own level of challenge, choosing size of numbers and even generating their own numbers.
- In the school which investigated pupil choice within differentiation, using pupil voice as a measure, a 1 to 10 scale rating for enjoyment and challenge in maths lessons was employed. Pupil voice was carried out in September and March as well as at mid points. Interestingly, the scores for enjoyment moved from 7.9 out

of 10, to 8.8 out of 10, an increase of 0.9. This could indicate that pupils had always enjoyed maths, but that this enjoyment had increased slightly as a result of the project. However the extent to which the pupils felt challenged moved from 4.1 to 8.9, which is an increase of 4.8. This significant change in pupils feeling challenged was something that both the pupils and teacher viewed positively. This work was carried out with Year 1 pupils.

Developing the learning environment to engage pupils in maths

- The aim of this project was to review the Reception class learning environment to enhance children's engagement with mathematics. Children in the setting had been observed to engage less with mathematical learning in their child-initiated learning (CIL) than other curriculum areas. Increasing opportunities for pupils to engage in mathematical activities in their CIL time was approached by linking the maths to the general topic e.g. 'people who help us' (focusing on the emergency services), with direct teaching and adult support during CIL to support the talk and thinking linked to mathematics e.g. using shapes to make pictures. The adults found that as opportunities for pupils to use their taught mathematics in their CIL increased, so did the pupils' motivation, and as a further consequence their mathematical thinking was enhanced.

Teachers working collaboratively in coaching teams to plan and teach and reflect

- CAME (Cognitive Acceleration in Maths Education) activities were used by coaching teams in one school. Each team planned and team taught a session and then reflected on the experience. The teachers who participated found this a particularly beneficial method of staff development, focusing of pupils' thinking skills the use of questioning. Staff found that by working alongside another colleague, they were able to have detailed discussions about the learning of individual children, which helped with formative assessment.

Recommendations

Although the projects from the 20 schools covered a wide range of aspects of teaching and learning within mathematics there were a number of common themes which have lead to a set of recommendations that other schools and settings might find useful:

- **Use school data to identify groups of pupils who may need to be better engaged or motivated within their mathematics, to support their progress.** For example identifying groups of pupils who may be underachieving in maths; either working below age related expectations or making slower progress than their peers. Consider common characteristics of these pupils: One school that identified a group of girls underachieving in their maths were able to impact on rates of progress through a maths club for the girls, developing their confidence and resilience.
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- **Make regular use of pupil voice.** A number of schools used pupil voice to gain insight into pupil perceptions of maths and to measure changes. Carrying out pupil interviews was a valuable experience for the teachers and pupils, giving an opportunity to discuss levels of confidence, areas of strength and development, and for pupils to give ideas to improve the mathematics learning experience. This was particularly beneficial when focus groups of pupils were identified first, for example pupils working below age related expectations, gifted and talented pupils, or a gender focus group, as a result of data analysis.
- **Give pupils frequent opportunities to talk productively throughout the lesson and collaborate in their learning.** Many teachers found that this was key to engaging and motivating pupils in their mathematics as well as deepening the learning experience and increasing pupil confidence in using mathematical language.
- **Consider the practical materials which could support children's understanding of key concepts such as place value and calculations.** Be careful not to limit the use of resources to the younger or lower ability pupils: Schools who investigated the impact of using practical resources, models and images found that it had a significant impact on engagement, motivation and progress in learning at all ages and levels. Pupils identified with 'gaps' in their learning benefited from tracking back to a practical representation to support their understanding.
- **Give maths a 'real life' context through the use of topics and projects when appropriate.** Pupils who understood the application of the learning to 'real life' scenarios were better engaged in the learning and enthusiastic; they were also better able to transfer their learning to other problem solving contexts. Pupil voice carried out in these schools showed that giving maths a context and purpose had a significant impact on pupil motivation in lessons. However, one school identified that it was important not to make forced or unnecessary links within topics or projects and that direct skills teaching is still essential.
- **Give pupils choices within their maths for example when to use resources, select their own level within differentiation or collaborate.** The experience in one school was that pupils' experience of challenge within maths went up significantly when they were given the opportunity to select their own level of challenge.
- **Increase the opportunities for dialogue between teachers and plan opportunities for teachers to work collaboratively e.g. team teaching.** Schools where teachers have the opportunity to work in coaching teams, or using a model similar to lesson study, find that this is a valuable part of their on going professional development, which in turns impacts positively on learning experiences for pupils.

Overview of titles and focus areas

School Name	Project focus area
Abbey CE VA Primary School	Can girl groupings in Maths improve confidence and lead to increased rates of progress?
Aboyne Lodge School	What impact does 'real life maths' have on disengaged children?
Brookmans Park Primary School	Does Numicon as a practical mathematical resource engage, motivate and accelerate children's learning?
Countess Anne CE VA School	How do these strategies engage and motivate underachievers in order to improve their progress? Questioning; Active learning-models & images/ games; Increased pupil talk.
Crabtree Infant School	The impact of pupil choices on motivation and engagement through selecting work level of challenge and resources. KS1 one focused.
Crabtree Junior Sch	Can Maths be taught successfully through small, real life projects?
Cuffley Primary School	How does the engagement of girls and boys differ and change as they move through the school?
Garden Fields JMI School	How can creative topic / project based maths be used to engage and motivate pupils, particularly girls, thus increasing progress?
Green Lanes Primary School	Will a more contextualised approach to learning create a change in pupil confidence and enjoyment in maths?
Holwell JMI School	Can we improve the engagement and motivation of our children and staff through real maths and investigations?
Kimpton Primary School	How effective is revisiting basic models and images of mathematical concepts, using manipulatives, on the engagement and achievement of older primary school children?
Little Heath Primary School	Does planning and teaching more memorable mathematics experiences, motivate and engage children within their own learning?
Our Lady Catholic Primary School	To enhance the learning environment to stimulate children's engagement and motivation in mathematical learning.
Purwell Primary School	Did using mathematical language with confidence increase participation? How does working collaboratively engage and motivate pupils?
Roundwood Primary School	Engaging and motivating more able and G+T pupils, through pitch and pace within the start of numeracy lessons and through the use of practical resources.
Samuel Lucas JMI School	How will a focus on developing reasoning through guided group work help to engage and motivate girls in Mathematics?
St Nicholas CE JMI school	Can increasing the teaching of mental arithmetic strategies improve attainment?
St Thomas More Catholic Primary School	Can the 'Building of Resourcefulness' in Mathematics engage and motivate pupils so that they can demonstrate that their Learning Power has been enhanced.

The Ryde School	How does children's understanding of subtraction help engage and motivate them when tackling mathematical problems?
Whitehill Junior School	Can effective staff coaching teams help to deliver maths sessions which enrich and deepen children's understanding of mathematical concepts?

Appendix

Schools who participated in the project:

Abbey CE VA Primary School
Aboyne Lodge School
Brookmans Park Primary School
Countess Anne CE VA School,
Crabtree Infant School
Crabtree Junior School
Cuffley Primary School
Garden Fields JMI School
Green Lanes Primary School
Holwell JMI School
Kimpton Primary School
Little Heath Primary School
Our Lady Catholic Primary School
Purwell Primary School
Roundwood Primary School
Samuel Lucas JMI School
St Nicholas CE JMI School
St Thomas More Catholic Primary School
The Ryde School
Whitehill Junior School

The individual reports from schools can be found on the Herts Grid for Learning website in the 'Research and Good Practice' section.