Developing Collaborative Approaches towards Securing Proficiency in Calculation: a project to enhance the professional development of Primary Mathematics Teachers.

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Abstract/Summary
In this project, lead teachers from three Oxfordshire schools worked together to support each other in designing Continued Professional Development (CPD) programmes to improve the teaching and learning of a key aspect of calculation in each school. The project aimed to explore the value and potential for schools working collaboratively to promote effective professional development in mathematics. Another intended outcome of the project was to identify and explore approaches that can be incorporated into school-based mathematics CPD in order to move forward classroom practice and enhance pupils’ ability to use mental and written calculation strategies effectively.

Outcomes from the project suggest that the structure and support provided by cross-school project meetings helped each lead teacher to identify a clear focus for CPD in their school and design and drive a targeted CPD programmes to address the chosen area for development in their school. The collaborative nature of the project promoted reflection on current provision, sharing of ideas and expertise and discussion about possible approaches to developing practice. This supported lead teachers in incorporating new ideas into their school-based CPD programme and adapting their approach to meet the particular needs of their school. Evaluation of the impact of the school-based CPD programmes identified some common features that appeared to be successful in developing teachers’ expertise in teaching calculation.

Background
Developing pupils’ ability to use mental and written calculation strategies effectively and with understanding is a fundamental element of the primary mathematics curriculum. The revision of the National Curriculum for 2014 will provide an opportunity for primary schools to review their current provision and consider how to further strengthen the teaching and learning of calculation. With the recent reduction of subject specific support at a local authority and national level, it is increasingly the case that such professional development will be driven within, and between, schools. This project was designed to develop and trial a model for between-school collaboration in designing and leading effective professional development programmes. It is hoped that this research will provide information and support for other schools about appropriate professional development models and approaches they might employ in their ongoing drive to improve pupil proficiency in calculation.

The headteachers of the three schools involved all chose to be involved in the project in order to continue to strengthen the teaching and learning of mathematics in their school:

- Five Acres Primary School is a larger than average-sized primary school located on the edge of a small village in Oxfordshire. A high proportion of pupils have a parent or carer in the armed services, so the number of pupils who join or leave the school part way through their education is high. Five Acres is a dynamic primary school committed to providing a rich, engaging curriculum for all of its pupils. The latest Ofsted inspection recognises that the headteacher has created a highly effective team to drive ongoing school improvement and the school takes a creative
approach to professional development. The headteacher was keen to be involved in this project as he hoped it would enable the school to make effective use of coaching and mentoring to support teachers in working together to continue to raise standards in mathematics for all pupils.

- Northbourne C.E. Primary School is an average-sized primary school situated in a large town in Oxfordshire. It aims to nurture excellence in all of its pupils. In its latest Ofsted report, the school was commended for ensuring that pupils make good progress from well-below-average starting points. However, pupils currently make more strongly accelerated progress in English than in mathematics and the school is committed to continuing to raise standards in mathematics teaching and learning in order to address this imbalance. The headteacher was therefore keen to be involved in this project as he hoped it would promote increased levels of confidence in the teaching of mathematics and support the school in its aim to develop creative, innovative approaches to CPD.

- St. Andrew’s C.E. Primary School is a larger than average-sized primary school located in a large village in Oxfordshire. Staff are committed to ensuring that the school is an exciting place to be where learning is fun, children have a love of learning and develop enquiring minds with a thirst for knowledge. The school’s recent Ofsted report highlights the steep improvement in attainment since the previous inspection, with results in English and mathematics now being well above the national average. The school’s lead teacher for the project has recently become a Mathematics Specialist Teacher and the headteacher was keen to make good use of his expertise through him working collaboratively with colleagues in school and also from other schools.

Aims of the Collaborative Teacher Project
The project was designed to provide a model for between-school collaboration towards developing effective school-based mathematics CPD. It was hoped that the project would promote the sharing of expertise, good practice and innovation in mathematics CPD across the schools involved. A further aim of the project was to provide a vehicle for each of the schools involved to improve teaching and learning in one particular aspect of calculation through carrying out a purpose-designed short programme of CPD activities.

Details of those involved in the Collaborative Teacher Project
The following three Oxfordshire schools were involved in the project:

- Five Acres Primary School, Ambrosden  
  **Lead teacher for the project** – Ann Dixon
- Northbourne C.E. Primary School, Didcot  
  **Lead teacher for the project** – Rachel Folan
- St. Andrew’s C.E. Primary School, Chinnor  
  **Lead teacher for the project** – Tim Nixon

The project was co-ordinated by Jane McNeill, Senior Lecturer in Primary Education at Oxford Brookes University. Dr. Graham Butt, Professor in Education at Oxford Brookes University, advised on the project.

A description of the Collaborative Teacher Project
The project involved collaboration between identified ‘lead teachers’ from each of the three project schools, supported by Jane McNeill from Oxford Brookes University. This group of four people constituted the ‘project team’. The collaborative aspect of the project was enabled through a series of four project meetings. At these meetings, the project team discussed examples of good practice from the schools and drew on relevant guidance, research and wider evidence of good practice to identify key features of effective CPD in mathematics and key features of effective practice in the teaching and learning of calculation.

The programme of project meetings ran in parallel to a series of activities that each lead teacher carried out in their own school, supported by their headteacher. Each lead teacher worked with colleagues in school to identify an aspect of calculation that was a priority area for development and then used ideas from the project meetings to design, drive, refine and evaluate a personalised school-wide CPD
programme to improve teaching and learning in this aspect of mathematics. Although each school’s CPD programme was personalised to meet the particular needs of the school, some guidelines were agreed. These were based on features of effective mathematics CPD identified through considering evidence of good practice. It was agreed that each school programme would involve all teachers taking part in at least two whole-school professional development meetings and carrying out between-session tasks. It was also agreed that each school CPD programme would include opportunities for the lead teacher to work in class with at least two colleagues through collaborative approaches such as lesson study.

The table below gives an overview of the model developed within the project:

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<thead>
<tr>
<th>Focus of project group meeting</th>
<th>Follow-up school-based activities undertaken by each school lead teacher</th>
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| **Initial ½ day project group meeting:** | • Share and review key discussion points from project group meeting and meeting outcomes with headteacher.  
  • Collect pre-project data in Y3 & Y6 to identify current pupil proficiency in mental and written calculation and problem-solving across all four operations.  
  • Enter marks onto spreadsheet to inform assessment and analysis of current strengths and potential areas for development. |
| • Share overview of each school context and reasons for taking part in the project.  
  • Discuss and clarify project aims, objectives, protocols and ways of working.  
  • Set context for the project by reviewing draft National Curriculum for 2014 and considering opportunities and challenges it offers in terms of developing calculation.  
  • Discuss document ‘Number and Calculation: Getting the Best Results’ (OUP 2012) and use to promote discussion of examples of effective practice in calculation within schools and potential areas for development.  
  • Plan use of data collection tool in each school. | |
| **Whole day project group meeting:** | • Share and review key discussion points from project group meeting and meeting outcomes with headteacher.  
  • Work with headteacher to draw up a detailed plan for an innovative school-based mathematics CPD programme to run over next three months (to include at least two whole-school professional development meetings with between-sessions tasks undertaken by all teachers and to include opportunity for the lead teacher to work collaboratively in-class with at least two colleagues).  
  • Share CPD programmes across project team.  
  • Begin to implement school CPD programme. |
| • Analyse assessment data across the three schools. Discuss strengths and weaknesses revealed. Identify priority operation for development within each school.  
  • Review current research evidence and guidance in chosen aspect of calculation to clarify subject knowledge and subject specific pedagogy that might be developed through school CPD programmes.  
  • Draw on research into effective mathematics CPD to identify and discuss key features that might be incorporated into CPD programme design.  
  • Draw on relevant experience, research and examples of good practice to begin to map out provisional plans for each school’s professional development. | |
| **Half day project group meeting:** | • Share and review key discussion points from project group meeting and meeting outcomes with headteacher.  
  • Together, agree any changes and continue to implement school CPD programme. |
| • Share one key area of success from each programme.  
  • Support each other in reviewing outcomes and impact of the school-based CPD |
programmes so far.
- Refine the ongoing programmes to build on successful outcomes so far and to overcome any potential challenges.
- Begin to consider key themes emerging from across the project schools. Consider how these might inform future practice.

**Half day project group meeting:**
- Review, compare and contrast outcomes and impact of the school-based CPD programmes.
- Identify similarities and differences across the school programmes. Discuss key themes.
- Revisit research and documentation used in earlier meetings in the light of the experience of the project.
- Review what we have learned from the project.
- Discuss evaluation of the project and plans to continue developments.
- Collect data to inform evaluation of the school CPD programme (and project more widely).
- Evaluate impact of CPD programme including through data analysis, questionnaires and semi-structured interviews of key members of staff.
- Write school report on CPD programme, identifying impact and plans for continued development.

**What has been learned from the project?**
The lead teacher from each of the three project schools collected data to evaluate the impact of the school involvement in the project. This included information on pupil attainment in the focus aspect of calculation and questionnaires from all teachers. In addition, the project co-ordinator carried out semi-structured interviews of three teachers in each school (headteacher, project lead teacher and one teacher involved in in-class collaboration). Evidence from each school’s self-evaluation, teacher questionnaires and interviews has been used to identify the key points below.

**The value of collaboration between schools in promoting effective mathematics CPD**

**Evaluation points common across all three schools:**
- The structure and support provided by the project group meetings helped each lead teacher to identify a clear focus for CPD in their school and design and drive effective CPD programmes to address the chosen area for development in their school.
- The collaborative nature of the project promoted reflection on current provision, sharing of ideas and expertise and discussion about possible approaches to developing practice. This supported lead teachers in incorporating new ideas into their CPD programmes and adapting their approach to meet the particular needs of their school.
- Cross-school project meetings enabled lead teachers to share experience and expertise. It was helpful to draw on examples of good practice that had been ‘tried and tested’. Most lead teachers and headteachers felt that it had been particularly valuable to have the opportunity to collaborate with schools they would not normally work with.
- As the project developed, the lead teachers valued the opportunity to work in a supportive context with colleagues engaged in similar activities. At project meetings they felt able to openly discuss the successes and challenges of their ongoing school CPD programme and support each other in adapting their approaches.
• The lead teachers found working with colleagues from other schools valuable, re-assuring and inspiring. It supported them in trying out new ideas back in school and led to a greater range of activities being included within their school-based CPD programmes.

• All headteachers felt that working with colleagues from other schools on this project had provided their school lead teacher with an excellent opportunity for professional development.

Five Acres Primary School:
• Discussion with lead teachers from other schools helped to extend ideas to be developed in own school.

• Working across schools offered opportunities to share deep subject knowledge in focus areas of mathematics. This promoted ‘reflective practice’.

Northbourne C.E. Primary School:
• Working with colleagues across the three schools was valuable in promoting reflection on work in school from new perspectives.

• This model has a strong potential for development locally within partnership networks.

St. Andrew’s C.E. Primary School:
• The lead teacher working with colleagues from other schools contributed to strengthened understanding of aspects of mathematics (particularly subtraction).

• The project provided opportunities for the lead teacher to trial a range of CPD activities and extend insight into successful CPD programmes.

Features that increase the impact of mathematics Professional Development programmes

Evaluation points common across all three schools:
• Identifying a small, specific area for development and then planning a series of targeted professional development activities with clear intended outcomes and a specified timescale helped to ensure that the CPD programme was tightly focused and productive.

• It was important that the CPD programme ran across the whole school. All teachers were involved in whole-staff professional development meetings. These meetings needed to have clear outcomes for staff and pupils.

• More than one professional development meeting was included in the programme. Between meetings all teachers were expected to carry out specific development activities in their own class. Outcomes from this were discussed and reviewed in future meetings. This ensured impact across the school.

• Incorporating opportunities for some teachers to engage in in-class collaboration through lesson study or team teaching within the CPD programme provided high-quality development opportunities. Working with colleagues in class promoted rich discussion on pupils’ learning and supported teachers in trying out new approaches to incorporate into their ongoing practice.

• The commitment, insight and enthusiasm of the lead teacher, supported by the headteacher, was key in driving the CPD programmes in school. The fact that lead teachers were given time to plan and prepare to lead the CPD programme within this project contributed to the high quality of the CPD activities.

Five Acres Primary School:
• It is important to identify a purposeful focus for professional development. Assessment information highlighted that children were not currently confident in using a range of strategies for division. Teachers knew that this was an important area for development so immediately ‘bought into’ the CPD programme.

• Collaborative planning and teaching between the project lead teacher and an NQT proved valuable. The NQT felt that it had been very helpful to share ideas and draw on the lead teacher’s experience and that it had informed her future teaching of mathematics.

Northbourne C.E. Primary School:
• The between-meetings activities gave teachers ‘ownership’ of the CPD programme. Staff created their own initial assessment (suitable for their year group) to identify how children were currently selecting and using subtraction strategies. This enabled them to think carefully about the calculations they were providing, thus helping them to fully understand the particular strategies reviewed in one of the staff meetings (sequencing, partitioning and complementary addition). Teachers then went back to their classrooms and carried out the initial assessment with a small group of more able children. They then worked with this guided group for two or three sessions focusing on the given strategies. After this, the group was given a final assessment (again devised by their teacher) which promoted a tight focus on how effectively the guided teaching moved on children’s learning.

• The use of relevant research as a stimulus for discussion within CPD meetings was successful in promoting detailed discussion around subtraction methods.

St. Andrew’s C.E. Primary School:

• Teachers devised their own assessment questions to review children’s current proficiency and understanding of subtraction. This ‘open’ starting point ensured that the CPD programme was tightly focused on areas of needs and took children forwards from where they were. Assessment of, and discussions around, children’s misconceptions in subtraction provided a meaningful starting point for professional development which was relevant to all teachers.

• Involving pupils directly, for example, through video of their learning in lesson study contexts ensured a strong focus on moving pupils’ learning forwards.

Approaches that enhance the teaching and learning of calculation

Evaluation points common across all three schools:

• Using assessment information on children’s current understanding in a particular aspect of mathematics as a starting point engaged all teachers and provided a clear and relevant purpose for professional development.

• The use of video to ‘capture’ and then review pupils’ current approaches to arithmetic and calculation provided a powerful vehicle for promoting rich professional dialogue between teachers.

• The expectation that all teachers would carry out tasks in their classroom between whole-school CPD meetings led to high-quality, focused discussion of children’s learning and progression in the particular aspect of calculation. Where schools also referred to recent research in their chosen aspect of arithmetic this promoted in-depth reflection on current practice.

• Opportunities for teachers to reflect on and discuss their own subject knowledge (for example through using the NCETM self-evaluation tool or carrying out a range of calculations in the school’s focus operation, comparing and discussing alternative strategies) was important in securing progression and good practice in the teaching of calculation across the school.

• Discussion around key aspects of pedagogy within whole-school CPD meetings was important in developing shared practice across the school (for example, embedding opportunities for talk for learning into lessons to enable pupils to explain, compare and refine their choice of calculation strategies or careful selection of appropriate models and manipulatives to promote deep conceptual understanding).

• Professional development programmes such as those undertaken in the project present meaningful opportunities to review school policy as a whole staff. The schools involved in the project all identified the importance of reviewing and amending aspects of their calculation policies in the light of their professional development programmes.

Five Acres Primary School:

• Reviewing the range of strategies that can be used for division and progression in teaching and learning as a staff has supported teachers in planning more precisely for the needs of particular groups of learners in their class.
Teachers created their own assessment tools to use within their class to establish children’s current choices and accuracy in using division strategies. Reviewing this assessment information as a staff raised the profile of assessment for learning in mathematics.

**Northbourne C.E. Primary School:**
- The use of video clips of children in the school explaining their subtraction methods promoted rich discussion between teachers in whole-staff professional development meetings. It also helped teachers to develop a shared vocabulary and the ability to talk more precisely about the range of methods available for subtraction.
- Review of pupils’ current responses to a range of subtraction calculations led to a staff focus on how effectively children were able to choose appropriate strategies for particular calculations. This, in turn, promoted discussion about ensuring that an appropriate range of strategies was explicitly taught across the school.

**St. Andrew’s C.E. Primary School:**
- Teachers bringing assessment evidence of children’s current proficiency in calculation to a professional development meeting to review and analyse together provided an excellent vehicle for focused development of practice. Analysis of children’s misconceptions led to increased focus on counting back, partitioning and decomposition within teaching to support rich understanding of these important skills that underpin effective subtraction methods.
- The use of video of children explaining their subtraction methods was valuable in capturing the impact of the activities teachers carried out between professional development meetings. This also highlighted the value of peer discussion around calculation methods within class.

**Impact on teachers’ practice**
The lead teacher of each of the project schools used evaluation information from the project to identify the impact of the project on teachers’ practice. Key outcomes identified by each school are identified below:

**Five Acres Primary School**
- The CPD programme increased teachers’ understanding of the range of strategies that can be used to carry out division and progression in the teaching and learning of these strategies.
- This has given teachers greater awareness of the key conceptual understanding and skills underpinning key division strategies.
- It has developed teachers’ skills in creating their own focussed assessment questions and activities to identify pupils’ progress.
- This professional development has led to increased use of short focused assessment of calculation strategies as an on-going part of mathematics classroom practice.

**Northbourne C.E. Primary School**
- Teachers have said that the CPD programme helped them to be ‘more aware of the different approaches to teaching subtraction’. It highlighted the range of strategies children need to be aware of and the importance of making this varied range explicit within teaching.
- The project has extended teachers’ subject knowledge around subtraction. One teacher said, ‘I feel more confident and have a wider range of methods I can teach and explain’. Another said ‘I am much clearer on what strategies are best for different calculations and why they are the best ones to use’.
- It has given teachers greater insight into the strategic use of models (including the Singapore bar model) to support understanding of subtraction strategies.

**St. Andrew’s C.E. Primary School**
- The CPD programme provided teachers with increased insight into the specific aspects of calculation that children in the school commonly found most challenging.
- It increased awareness of the value of using manipulatives to help children overcome misconceptions.
- It improved teachers’ ability to reflect on and review their own mathematics subject knowledge (for example using the NCETM self-assessment tool).
- It developed teachers’ understanding of how to teach subtraction successfully using their insight into progression in learning subtraction from foundation stage onwards.
It gave teachers greater security in the careful use of appropriate language and vocabulary to explain approaches and methods.

Impact on others
Five Acres Primary School
- Children are increasingly able to make effective choice of methods for particular division calculations.
- Strengthening the use of assessment information has led to some re-grouping of pupils for calculation activities. It has also led to more focused differentiation.
- Short focussed assessments are now a more integral part of classroom practice in calculation with outcomes of assessments shared with pupils as a learning tool. In this way pupils are more actively engaged in their progress in calculation.

Northbourne C.E. Primary School
- Children (especially the more able) have a deeper understanding of a range of subtraction strategies and can talk about them in detail, explaining why they might choose to use one strategy over another for a particular calculation.
- Most children can now see that, for particular subtraction calculations, some strategies may be more efficient than others. This is helping many children to make effective choices, though some children are still struggling with choosing an efficient method.
- The use of these more efficient and appropriate methods has meant that children are now answering calculations more accurately than before.
- Foundation stage and Year 1 children have started to link subtraction to 'finding the difference' (complementary addition) and know that there are different ways to subtract.

St. Andrew’s C.E. Primary School
- Children are becoming more confident in talking about their approaches to calculation through increased use of peer talk within lessons.
- Children are choosing to use a greater range of manipulatives to support their understanding of processes in calculation.
- Children are becoming increasingly secure with key underpinning skills for subtraction, such as counting backwards.

Wider impact:
Five Acres Primary School
- The number of pupils who join or leave Five Acres part way through their education is high as many children have a parent in the armed forces. In the light of the project, the school has integrated assessment of pupils’ calculation strategies into entry assessment procedures for children arriving at the school part-way through their school career.
- The school is planning to extend professional development in calculation to teaching assistants so that they can continue to support children’s development in calculation effectively.

Northbourne C.E. Primary School
- The headteacher is planning to incorporate aspects of the project into on-going work alongside partnership schools.
- The project provided a good way for the lead teacher to work directly with colleagues across the school and to develop their role in the school in terms of leading CPD.

St. Andrew’s C.E. Primary School
- The project provided a good way for the lead teacher to work directly with colleagues across the school and to gain insight into practice across the age ranges.
- The lead teacher is active in working alongside mathematics subject leaders in local partnership schools so is likely to share outcomes and ideas from the project with colleagues from other schools.

Advice to teachers who may want to try something similar
The following key points have been collated from the evaluation reports and interviews across the three schools involved in the project:
• Identify a strong leader for the professional development programme who has a high level of knowledge and understanding of the area of focus.

• Pick the area of focus for your professional development programme carefully, using a range of information including detailed assessment of children’s current proficiency. Identify a specific (small) aspect for development that is manageable and set clear goals and deadlines.

• Ensure that all teachers are actively involved in the professional development programme through incorporating in-class activities as part of the programme.

• Include the use of video in class-based CPD activities to promote deep reflection on current pupil proficiency and to engage pupils in the development programme. Video extracts provide an excellent vehicle for promoting professional dialogue about mathematical thinking and progression in staff meetings.

• Incorporate sufficient time within the programme for staff to reflect on practice. However specify a clear, limited time scale for the project in order to maintain focus and momentum.

• A whole-school (and between-school) calculation CPD project such as this promotes rich discussion around calculation strategies and approaches to teaching. This will impact on classroom practice and children’s learning and give the school a clear vision for the on-going development of calculation. So, go for it!

References and resources produced or used
• ‘Number and Calculation: Getting the Best Results’ (OUP 2012)
• Ofsted Report ‘Good practice in primary mathematics: evidence from 20 successful schools’ (2011)
• Ofsted report ‘Mathematics Made to Measure’ (2012)
• Summary of ‘Researching Effective CPD in Mathematics Education’ (RECME, 2009)
• Summary of ‘Ensuring Effective CPD for Teachers of Primary Mathematics’ (ACME, 2006)
• NCETM Self-evaluation tool