Improving Pedagogical Approaches to the Teaching of Algebra in the Transition Phase

By Sarah Coldbeck of Mereside School

Abstract/Summary
This project utilised a collaborative approach to investigate the necessary progression of skills from pre algebraic understanding through to pure algebraic working. Teachers from primary and secondary phases worked together to unpick the necessary skills children need to develop, utilising the new National Curriculum to identify possible barriers and milestones to understanding. Through a lesson study approach and observation, cross phase teaching and learning characteristics were established. This was complimented through a conference which supported clarity in the necessary teaching and learning steps to ensure conceptual and procedural understanding. Co-constructed lessons were then taught across phases leading to the development of a transitional set of lesson materials. These materials will support future teaching and learning across and within schools, promoting development of skill rather than promoting 'quick fixes' to address gaps in understanding and knowledge. As a result of the project, staff developed an understanding of an unfamiliar phase of teaching, supporting the development of pedagogy and subject knowledge across their own key stage. Through discussion and exploration, key milestones in learning were identified, supporting planning and identifying the necessary progression of skill within the topic.

Background
The project arose due to the opportunity to employ cross phase work. The Teaching Alliance has both primary and secondary schools and although cross phase working is part of the remit of the Alliance, the opportunity to explore one aspect in detail across primary and secondary school partners allowed specific and focussed work to improve CPD, leading to improvements across schools and staff departments. Algebra features heavily in the new National Curriculum and this project supported the skilling up of staff on the progression of algebra and benchmark points of learning for the children.

Mereside Primary School is a single form school situated in the south east of Blackpool. Within Blackpool there is a great deal of variation, and the Mereside estate, which the school serves, is one of the areas with the highest levels of deprivation. 90% of the school's pupils live in the highest deprivation band in England (overall Blackpool has 34.1% of its pupils in the highest deprivation band). The school is involved in the Blackpool Maths Project, a project being supported by the National Maths Partnership and led by Lynn Churchman. With this whole school focus of maths being prevalent, the school is actively looking for ways to strengthen maths teaching and learning, including ways to support transition for vulnerable pupils within the school.

Year 6 results increased significantly last year but attainment for higher ability children remains below nationally expected levels. With a focus on developing teaching and learning in year 6 through lesson study this key year group will be strengthened and attainment for pupils improved further. This project will also strengthen teaching and learning not only in year 6 but also across school, reinforcing links across the curriculum.

Hodgson Academy is a mixed 11-16 comprehensive school, which has chosen to be involved in the project in order to develop stronger pedagogical approaches across the transition years as well as to help to promote this improvement within the other schools involved.
Montgomery Academy has just over 1400 pupils aged from 11-16. Last year 73% of pupils achieved A*-C in maths and this year it is aiming for 80%+. One of the school aims is to develop links with primary schools in order to develop more effective transition. We would like to compare schemes of work in years 6 and 7 and approaches to teaching so that pupils have a more consistent experience.

Garstang Community Academy is a small rural school with 750 students on roll aged between 11 and 16. The overall effectiveness of the mathematics department was rated as ‘satisfactory’ in the most recent Ofsted Inspection in 2011. At GCSE, 65% made 3 levels progress from Key Stage 2, 69% gained a grade C or above and 10% gained a grade A*/A. In 2012, 78% made the expected 3 levels of progress, 77% achieved GCSE grades A*-C and 26% gained A*/A. Monitoring records indicate similar results are expected in 2013. This progress is evidence of an ambitious department with a track record of significant improvement. We feel our maths team can offer support to other local schools whilst also enhancing our own learning journey by developing improved cross-phase maths teaching and learning.

**Aims of the Collaborative Teacher Project**
To support transition across the KS2/3 boundary through the collaborative development of a consistent and systematic approach to teaching and learning algebra.

**Details of those involved in the Collaborative Teacher Project**
Leoni Smith (Garstang Academy)  
Simon Nield (Hodgson)  
John Gunn and Simon Morriss (Montgomery)  
Lauren Hollis (Mereside) Year Six Teacher  
Sarah Coldbeck (Mereside)  
Shelia Eastwood (CPD Provider)

**A description of the Collaborative Teacher Project**
At the beginning of the project each school involved in the project was asked to select staff members within their setting who could drive improvements within teaching and learning in algebra. Schools were asked to also indicate a senior leader in school to support staff members work in disseminating aspects from the project within school to ensure wider impact.

An initial meeting of these staff members took place where the project aims and structure was explained. From this meeting a lesson study group of the four schools involved was formed, the group comprising of one primary school and three secondary schools. As a starting point for the project lesson observations of pupils across the transition phase were arranged. These observations allowed all teachers involved in the project the opportunity to investigate algebra teaching and learner response. Observations were of pre algebraic teaching of primary pupils in year 6 and observations in secondary schools of a developing algebra lesson use in year 7 to pure algebra in year 10. All teachers observed each other teaching as a lesson study group and were observed teaching by the rest of the teachers involved. In line with lesson study approaches teachers were asked to note effective learning of pupils through focused observation of the learning of key students identified by the class teacher.

After these initial observations a day meeting of all schools involved in the project then occurred. The morning provided an opportunity for teachers to feedback on each of the lessons observed. This feedback concentrated on examples from each observation of effective learning and impact on the focus children initially observed. Through this discussion key milestones in learning were identified which would form the basis of co-constructed lesson plans. This discussion focussed on pupil learning enabled the progression of number and algebra skills to be identified, allowing a common ethos and understanding to be established. The day then comprised of a morning CPD session via the input of an external consultant Shelia Eastwood. During this input models and images to support understanding of algebra were discussed.

Teaching activities to promote understanding of the identified ‘milestone’ aspects of algebra within the new National Curriculum were discussed and explored. The use of rich open tasks focused on assessing understanding through application of questions involving multiple
representations such as use of taktiles as in the activity below.

**Tak-tile Areas**

This has an area of \( a \) and this has an area of \( b \)

So this shape has area \( a + b \)

Examples of these activities are included in the lesson materials produced as a result of the project. The three identified aspects identified as a focus for the project were Symbol Representing a Number, Geometry links with Algebra, and Equivalence.

As an outcome of the observed lessons and the CPD session, teachers constructed lessons during the afternoon of the day meeting, allowing pedagogy discussed to be built upon and strengthened in terms of daily practice. These lessons were designed to be taught in one pair and in one team of three teachers in a team-teach fashion. Lessons were designed to address one of the three main aspects identified in the initial lesson observations and CPD session. During the planning of these lessons the teachers were again asked to focus on the individual students from the initial observations, ensuring activities and lesson structure addressed their individual needs and learning requirements.

The lessons were then collaboratively taught within the organised teams of teachers, leading to two separate lesson study teams. During these lessons the teachers were again asked to focus on the individual students from the initial observation and the impact activities had on their learning. Both teams then, as a whole, drew together for a final full day. This was designed to allow participants to review the second round of lesson planning and teaching in reflection of the CPD session provided on the previous training day.

Feedback from lessons was derived again with a focus on learning. Impact of the collaborative lessons was gathered in terms of perceptions of pupil engagement and depth of understanding of the selected aspect of algebra i.e. either Symbol Representing a Number, Geometry links with Algebra and Equivalence. Each team fed back on the lessons and the different activities they employed in planning and teaching. Across both groups teachers felt that use of the open tasks supported discussion on aspects of algebra and allowed assessment of depth of understanding of selected concepts to be assessed. To build on this, the joint planning of an effective transition unit in algebra was completed, which could be used beyond the lifetime of the project. This unit took account of all the findings from the lesson study and utilised pedagogical approaches developed during the co-construction of the lessons taught in teams.

Lesson plans are within the appendix of the project. Each of the three identified aspects were taken in turn and lessons already taught as part of the team teach section of this project were reviewed and amended for inclusion in the lesson materials as required. Lesson plans for both year 6 and 7 with the same teaching resources being used if appropriate but with challenge or support being noted to support teaching and learning. Prior learning and extension aspects were also included to support teachers in using the materials in their practice. The afternoon of the day session was then used to complete lesson plans for each year group with the group as a whole acting collaboratively to formulate an agreement on the necessary progression of skills, effective models and images, consistent and appropriate language and teaching approaches to apply in practice across the key stage boundary.
What has been learned from the project?

Mereside Primary School: Pupils in year 6 all accessed the collaboratively planned lessons on algebra. The project supported the development of the year 6 teachers subject knowledge, specifically on the progression of skills required from pre-algebraic understanding to more developed algebraic application. The use of rich tasks requiring application of knowledge alongside multiple representations impacted on areas outside of algebra, also supporting elements of shape and number in planning and teaching.

High School A: Staff were already employing the use of multiple representation in teaching but the project highlighted its importance in the teaching of algebra. The impact of the use of rich tasks to support assessment of learning rather than closed tasks was an outcome gained from the project. This focus allowed an analysis of impact to be measured in terms of pupil engagement and understanding.

High School B: The impact of the lesson study approach to CPD allowed this school to assess current training already in place. The focus of this training had been centered on assessment of learning and not for learning. The rich tasks utilized in the project allowed CPD to be altered to include a dual focus, supporting dissemination across the maths department.

High School C: The use of multiple representations, especially use of taktiles in algebra was an area that had not been fully utilised within this school. The impact of this representation on pupil learning ensured that all teachers and children across the department were shown this consistent model through the teacher involved in the project to ensure prolonged impact on teaching and learning.

Impact on teachers’ practice

Transition between year 6 and 7 has caused difficulties in terms of providing a consistent approach to the teaching of algebra. At the onset of this project it was clear that preconceptions about the teaching of children within both stages were evident from both the Primary and Secondary teachers involved in the project.

This project enabled teachers to review teaching pedagogy and practice, to assess children’s learning in algebra, and identify the necessary milestones for true conceptual understanding. Teachers have gained a better understanding of progression of skills, especially through the identification of the three main aspects of algebra within this project, Symbol Representing a Number, Geometry links with Algebra and Equivalence.

Supporting assessment of children’s understanding through open-ended tasks utilising multiple representation supported learning of the focus children identified at the beginning of the project. These children were identified primarily as those from vulnerable groups within school. Girls were in the majority of cases identified as focus children, in discussion it was their reticence to engage in lessons which resulted in them being focus children. In all of the teacher feedback it was these children who benefited most from completing activities which involved multiple representations as they could apply their knowledge in a systematic manner. Their engagement and understanding was identified as being of a much higher level. One teacher commented ‘I never valued the use of open tasks to support assessment’ whilst another noted that ‘multiple representations support not hinder pupil understanding.’

Perhaps the unexpected outcome was one of the most rewarding, the collaborative nature of the project identified preconceptions of practice within each key stage. One secondary teacher commented on a lesson that ‘I never knew children were taught to that level at this age.’ Over the course of the project joint working supported a better understanding of the child’s journey within algebra through shared learning milestones.

Impact on others

This project gave teachers professional development on a consistent approach to the teaching of algebra whilst observing its impact on teaching before this was disseminated. The lesson study approach allowed a model of school improvement to be shared within each school through the link with senior leaders. Having a consistent approach to focusing assessment of impact on focus
children within each setting allowed for detailed and specific discussion on impact. This also supported the formation of lesson plans as focus children could be directly considered to ensure it remained focused on addressing learning milestones. Open ended tasks to support assessment of and for learning are being utilised in each school and further lesson study groups are also being developed to address consistency in the teaching of algebra over the next term within three of the schools involved.

Advice to teachers who may want to try something similar
Although challenging at times due to the different nature of the schools involved and from pre-conceived ideas about each phase held by some of the teachers, this project has enabled change to be observed and noted in each school involved. From the collaborative nature of the aspects completed, teachers have challenged and supported practice of each other in a constructive and enabling manner. By ensuring senior leaders in school were fully aware of the aims of the project and actions within it, dissemination of project aspects were also enabled. This is a key aspect which needs to be considered.