Raising achievement in mathematics through supporting transition from primary to secondary school

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Abstract/Summary

Five secondary schools and five primary schools collaborated on a project aimed at better understanding issues surrounding transition in mathematics and identifying a policy or approach that could address this. The particular foci of the project were lower and higher achieving pupils based on prior attainment at the end of KS2. Analysis of data had shown that these groups were more likely to secure less than expected rates of progress from end of KS2 to GCSE.

The lead for mathematics from each school joined the project and in the vast majority of cases a second teacher from each school who had a particular associated interest and role in transition and maths also participated. This meant there were nineteen participants including Rosamund Sutherland who was the improvement agent.

The group used a combination of pre meeting and gap tasks, regular face to face sessions, paired reflection as well as reciprocal visits to schools. Through these activities the participants explored progression in the teaching of key mathematical concepts across the school phases and identified those areas that formed potential barriers to securing sufficient progress. The areas were further analysed and investigated through visits to classrooms, work scrutiny and pupil interviews.

The findings were drawn together in a draft transition policy and project so that pupils in the participating schools will all complete exemplar tasks this summer. These tasks capture the areas the group found to be causing barriers to securing transition and also provide the opportunity to demonstrate recoding methods and exemplify standards of presentation. This work will then be placed in the front of books in year 7 to better support accelerated progress and continuity across transition boundaries.

Background

There is a growing body of research, both in this country and internationally, which associates the transition of pupils from one phase of education to another with underachievement (Evangelou et al, 2008). In particular there is very little understanding between teachers of mathematics in primary and secondary schools with respect to pedagogy, assessment and mathematical proficiency (Sutherland et al, 2010). There is also evidence that pupils from poor families are likely to underperform in the English educational system and this is particular the case for mathematics (Clifton & Cook, 2012). Moreover there is evidence that the high-stakes assessment regime can lead secondary schools to prioritise borderline C/D mathematics pupils in order to reach the government’s floor targets in terms of GCSE results (Mansell, 2007). All of these factors can lead to pupils underperforming at GCSE level and above.

The project was based on the view that pupils who perform relatively highly at KS2 in mathematics, do not always progress to high attainment at GCSE level and beyond. At the same time those pupils who perform below the national average at KS2 in mathematics are not always given the support they need at secondary school.
The project brought together a group of five primary and five secondary teachers of mathematics. The primary school phase partners were:
- Bridge Farm Primary School (Ofsted grade 1), two teachers;
- Fair Furlong Primary School (Ofsted grade 2), 3 teachers including the lead;
- Fishponds C of E Academy (Ofsted grade 3), 1 teacher and 1 HLTA;
- Knowle Park Primary School (Ofsted Grade 2), 2 teachers;
- Whitehall Primary School (Ofsted grade 1), 2 teachers.

The secondary school phase partners were:
- Bristol Brunel Academy (Ofsted grade 2), 1 teacher;
- Cotham Secondary School (Ofsted grade 1), 1 teacher;
- Merchants’ Academy Secondary (Ofsted grade 2), 2 teachers;
- Bristol Metropolitan Academy (Ofsted grade 2), 2 teachers;
- St Mary Redcliffe and Temple School (Ofsted grade 1), 2 teachers.

There had previously been some collaborative work between four of the primary schools and the lead was the headteacher representative for the Bristol Steering Group for mathematics. The project proposal emerged from these groups and schools were invited to participate. Although all of the primaries feed into at least one of the secondary schools participants were not chosen primarily on this basis but rather to ensure a range of schools in terms of performance, geographical location and wider community. In addition all participating schools were nominated by headteachers where transition was a key development point for their School Improvement Plan and where collaborative research based enquiry was a new but very much welcomed and supported approach.

**Aims of the Collaborative Teacher Project**

- To bring together a group of primary and secondary teachers of mathematics in Bristol who are committed to develop understanding of transition in mathematics across the primary / secondary phase.
- To develop understanding of how transition in mathematics across the primary / secondary phase impacts on pupils and young people from poor families.
- To obtain evidence from statistical data of progression in mathematics for young people, with a particular focus on differences with respect to socio economic background and gender.
- To investigate the progression of pupils who were high and low attaining in mathematics at primary school at post 16 and beyond.

**Details of those involved in the Collaborative Teacher Project**

The mathematics leader from each school was involved in the project and each of the primary schools and three out of the five secondary schools also engaged a second member of staff who had a particularly interest and responsibility for the subject, especially around transition year groups. This included an HLTA responsible for booster in year 6 and 7, a member of the NCETM who has a Doctorate with a specialism in more able learners, year 6 class teachers and KS3 or KS4 leads. The group rapidly expanded beyond the schools identified in the original application when news spread about what we were researching.

**A description of the Collaborative Teacher Project**

The project involved a pre meeting and gap tasks, regular face to face sessions, paired reflection as well as reciprocal visits to schools. Although we had a clear plan at the outset of the project the content and focus developed across the meetings as our research progressed. The teachers began by following lines of enquiry in their own schools regarding the challenges presented by transition in terms of the impact on progress secured in different groups of pupils in mathematics. The team members each presented their findings and the group as a whole concluded that although there were many similarities in the ideas expressed they predominantly focused on practical issues surrounding transition rather than specific potential conceptual and pedagogical issues surrounding the development of understanding in mathematics.
In the early stages data was a prime source of information, we used project school based assessment analysis as well as statistical data provided by Rosamund Sutherland derived by a project funded by Bristol University. Analysis supported the view that lower and higher attaining pupils in Bristol were least likely to secure at least expected rates of progress by the end of KS4 based on prior attainment at the end of KS2.

It was agreed that teachers needed to gain greater understanding of the differences between the curriculum coverage, teaching style, the development of concepts and the use of models and images to support learning in primary and secondary phases. The group concluded this would better reveal the pedagogical issues surrounding transition in mathematics and support development of practical and theoretical advice in developing a city wide subject specific policy for transition.

The group members each researched and presented progression maps of the development and teaching approach to a range of concepts including algebra, calculation and shape and space. This supported teachers in identifying where there is the greatest disparity between the approach taken in primary and secondary settings. It also revealed how ignorant teachers were of the approach and curriculum content as well as the models and images used in other phases. This allowed the project to identify key areas where heightened awareness in staff might well better support effective teaching and ultimately close the gap for lower and higher performing pupils. Following this reciprocal visits were made to further explore these lines of enquiry and interviews with pupils performing broadly at 4c and 5c in each setting were carried out to harness pupil voice.

What has been learned from the project?
The following is a very brief summary of observations, notes and transcripts that reflect the learning of teachers in each setting. These led to the collective findings agreed upon by all the collaborating schools and these will be summarised at the end rather than duplicating them under the learning for each school.

*Bridge Farm Primary School*
Originally took the curricular aspect of time and mapped the progression in teaching and learning across the primary and secondary phases. The teachers found the concept was demanding for pupils in both phases but that the secondary teachers had not previously realised proportionally how little time was spent on the subject in primary schools. When pupils were interviewed generally those performing at L5+ were much more positive than their peers e.g. *I'm really enjoying maths and I can't wait to do it at secondary school* compared to an example from a pupil working at 4c who commented *I don't think I'm good at maths – most of my class are quicker than me*. In addition the teachers observed a lack of practical activities in their secondary school visit and much reduced opportunities for paired discussion and collaborative learning as compared with the style of delivery in their own setting. Bridge Farm teachers agreed with the wider team that the concept of time was not an aspect that we would include in detail in a transition policy. However all phases agreed we needed to ensure teachers address time in an ongoing way in a cross curricular manner regardless of the age of the pupils and that it was an essential life skill that can be marginalised in the curriculum. The teachers also reflected that they would like to do more to embed basic skills for pupils working at 4c before they enter secondary school as well as ensure transition schools had the practical resources available that these pupils along with their more able peers would benefit from. They also very much welcomed the dialogue that had developed between maths leaders and felt this should be an entitlement for all schools and indeed should be extended to other subjects.

*Fair Furlong Primary School*
CTP3013 – Fair Furlong Primary School

Originally took the curricular aspect of ratio and proportion and mapped the progression in teaching and learning across the primary and secondary phases. The teachers concluded that the area did not cause too much difficulty in terms of progression from primary to secondary school although the KS4 staff were surprised at how the concepts were modelled and the depth of work covered in the primary phase. When pupils were interviewed the teachers found similarities to others in the confidence of the more able group e.g. *I made great progress. I enjoy maths because every day we do different things. I like the sorting out and solving of problems.* In contrast teachers noted that they were the only ones to find pupils working at L4c presenting as optimistic about their learning. E.g. *I enjoy maths especially the questions where you get to solve a problem. I like to learn more and see my mistakes and this helps me to carry on.* During reciprocal visits the teachers noted that where the pupils were using methods that had been embedded in primary school e.g. the grid approach to multiplication, pupils reported they found extension into more challenging questions enjoyable and were confident in their approach. The teachers also explored how planning was generated in the secondary setting through a scheme approach. They noted that this did not support the KS3 staff in assessing previous understanding and adapting teaching to the specific needs of the sets. Fair Furlong agreed with the wider team that ratio and proportion was not an aspect that we would include in detail in a transition policy. However it did support the view that visits to primary schools from teachers from KS4 as well as the more traditional KS3 were extremely revealing and helpful in exploring the depth of possible prior learning. The teachers also agreed with secondary colleagues in a feeder school that the new curriculum was an excellent opportunity to work on cross phase planning to further strengthen differentiation and the use of models and images to support learning especially for lower attaining and more able pupils in transition. Together with exploring the positive views of pupils at 4c this would make another project but the collaborative links established in the research and the common understanding secured has ensured these teachers are well placed to move forward with this work.

*Fishponds C of E Academy*

Originally took the curricular aspect of area and perimeter and mapped the progression in teaching and learning across the primary and secondary phases. Again the wider group concluded that it presented little barrier to securing progression in KS3 and beyond. However, interestingly both primary and secondary staff agreed that pupils tended to confuse the two concepts throughout their schooling. In addition the teachers noted during their reciprocal visits that the emphasis of maths in real life contexts and application to cross curricular understanding was much more evident in primary than secondary lessons. Fishponds C of E Academy teachers agreed with the wider team that area and perimeter was not an aspect that we would include in detail in a transition policy. However it did support the view of the wider collaborative group that ensuring explicit links to real life contexts and cross curricular understanding are essential to secure effective learning. Indeed it seemed that the scheme approach used in the majority of secondary departments sometimes caused a greater barrier to this than when planning was generated by a teacher for a specific year group or set.

*Knowle Park Primary School*

Originally took the curricular aspect of place value and mapped the progression in teaching and learning across the primary and secondary phases. The teachers found there was some lack of knowledge of how this concept would be developed across the primary phases and the associated language. For example secondary colleagues were unaware that the vast majority of pupils in years 5 and 6 would be familiar with a decimal number line and in some cases secondary teams were teaching pupils a *trick* of moving the decimal point when multiplying or dividing. The teachers also concluded that it would be mutually beneficial to have year 7 teachers join year 6 lessons to help understanding about many aspects but especially productivity and pedagogy. Knowle Park Primary teachers agreed with the wider team that aspects of place value would be an important area to ensure explicit reference was made to in a transition project or policy. The collaborative group concluded that the language used underpinned wider work e.g. in
calculation and that ensuring all teachers and especially those in year 7 were aware of this would be important in strengthening transition and thus securing accelerated progress. The teachers also agreed that the opportunity to visit year 6 mathematics lessons should be an entitlement for all year 7 teachers in schools agreeing to follow the city wide commitment to transition in mathematics policy.

Whitehall Primary School

Originally took the curricular aspect of subtraction and mapped the progression in teaching and learning across the primary and secondary phases. Although the teachers agreed that broadly progression in subtraction was effective across the ability range there were some aspects that proved more challenging and where there was some disparity in teaching and understanding of approach, eg. the use of a number line to calculate *find the difference* problems. This linked to another aspect the teachers learned of during their visits and was explored with the wider group.

This was that secondary colleagues shared that they can struggle to know how to support a pupil who reaches year 7 below a L4 as they cannot back track enough. This was very candid of them and challenges primary perspectives, who would assume that maths graduates would naturally understand progression of the subject. This also mirrored the problem experienced by many primary teachers regarding able mathematicians and having subject knowledge to be able to teach at high L5 and at L6. The teachers also interviewed pupils who supported the desire to work collaboratively. E.g. a pupil at L4c reported *I like working when my friends help me when I'm stuck and understand it better*. Similarly a pupil at L5c notes *I like working in a group rather than solo because in a group if I get stuck on a question I can see how other people are working out.*

Whitehall Primary teachers agreed with the wider team that subtraction was an area that would be core to a transition approach or policy and that particularly the move from a number line through an expanded method to the formal approach should be modelled and exemplified.

Having been key to opening discussion surrounding concerns in understanding teaching approaches for pupils at either end of the ability spectrum leaving primary and in year 7 the collaborative group agreed that information sharing regardless of feeder school was invaluable in developing individual teacher expertise as well as informing transition policy.

Bristol Brunel Academy

Originally took the curricular aspect of measures / shape and space and mapped the progression in teaching and learning across the primary and secondary phases. The wider group agreed that the teaching approaches and models used were broadly similar but there was some basic misunderstanding regarding practical teaching methods. For example, the secondary teachers were not aware that compasses were not taught in L4-L6 primary curriculum and that the use of the protractor is a minimal. In addition through the reciprocal visits the Brunel teacher proposed further exploration of how work is presented and marked in mathematics. Generally it was found for a variety of reasons that marking was more consistent and standards of presentation were high in the primary settings. The Bristol Brunel Academy teacher agreed with the wider team that measure and shape and space were not areas that would feature strongly in a transition policy with a purpose of securing accelerated rates of progress. However secondary teachers did agree that knowing which practical skills would be introduced for the first time in secondary would be important to share as this would inform the starting point and the support required to develop skills rapidly in early lessons. In addition the whole group agreed it would be useful to include an element of expectations for standards in presentation and marking in transition materials. This would support the maintenance of high expectations and securing continued progress across the key stages and transition points.

Cotham Secondary School

Originally took the curricular aspect of multiplication and mapped the progression in teaching and learning across the primary and secondary phases. In almost all the schools the grid method was used as the primary way of modelling and calculating for multiplication. In one secondary there was no school wide agreed approach and individuals preferred to use the *skeleton bones* technique. During visits to the secondary classes primary teachers reported the pupils showed
greater enthusiasm and confidence for the lesson where teaching was based and extended from previous learning and visual models. The teacher from Cotham also highlighted the challenges faced by primary non maths specialists in ensuring lessons secure a fundamental understanding of the mathematics behind a concept as well as the algorithmic method. The Cotham Secondary School teacher agreed with the wider team that multiplication was an area that would be core to a transition approach or policy and that particularly showing how a word or contextual problem might be presented and the expected standard of written calculation and recording. In addition the teacher proposed that the transition policy or approach would support greater common understanding of the mathematics behind concepts. All collaborators agreed that this would be supportive for colleagues teaching across the age range.

Merchants’ Academy Secondary

Originally took the curricular aspect of negative numbers and division and mapped the progression in teaching and learning across the primary and secondary phases. The teachers concluded that negative numbers did not cause too much difficulty in terms of progression but that division was a key stumbling block. This concept more than any other caused the greatest debate and, although not entirely so, it was found that the vast majority of primary aged pupils in the project schools would move to secondary without having used or even seen modelled the bus stop approach. The vast majority of primary lessons used the chunking approach and this was almost exclusively not used in secondary at all. When pupils were interviewed there were similar findings to primary colleagues especially with pupils working at 4c. Higher attaining pupils were slightly less upbeat about their skills as a mathematician than their primary school peers although generally had remained positive. E.g. I am an ok mathematician. I need to concentrate and improve more. It has got harder since primary but I think I am making progress. The teachers also noted that there was a limit in knowledge and in some cases a total lack of knowledge regarding the content taught in the opposite phase of education. Therefore the teachers proposed that greater use of AFL should be included in lessons when a topic is introduced to pupils in secondary level to establish the actual range of knowledge and understanding before the aspect is developed further. Merchants’ Academy Secondary teachers agreed with the wider team that division would be an important area to ensure explicit reference was made to in a transition project or policy. In addition they led discussion around meaningful AFL / diagnostic assessment and adaptation of planning in view of findings. The group agreed that rather than a written policy as such a practical piece of work that exemplified current levels of working for year 6 pupils at the end of the year in core areas such as division would be an excellent starting point for these sessions in year 7.

Bristol Metropolitan Academy

Originally took the curricular aspect of algebra and mapped the progression in teaching and learning across the primary and secondary phases. Although secondary teachers in the project were generally surprised at how much was covered in the primary settings there did not appear to be any significant barrier to progression, certainly for more able pupils. It was agreed though that for some of the pupils working in primary at 4c and below and who may well have just scored a 4c in their SAT that their breadth of coverage of algebra may well be significantly narrowed by the requirement to address basic skills. The Metropolitan teachers especially explored the approach to marking mathematics in the primary settings and found the daily approach and detailed feedback to be very much in contrast to their secondary experience. Whilst they did not necessarily agree with each other or the wider group of both primary and secondary teachers they acknowledged that the approach of using response to marking in books led to gaps being closed and progress being secured at an individual level. Bristol Metropolitan Academy agreed with the wider team that algebra would not necessarily be a key aspect to include in a transition policy. However the group did agree that ensuring secondary departments use a diagnostic assessment approach when addressing the concept early in years 7 and 8 would be important in securing progress for all pupils and especially the less able.

St Mary Redcliffe and Temple School
Originally took the curricular aspect of transformations and probability and mapped the progression in teaching and learning across the primary and secondary phases. The teachers found that probability posed few barriers to the target groups of pupils securing sufficient progress. In addition transition in the concepts of transformations was not especially problematic although there were elements that it was helpful to uncover were not taught in the primary curriculum. E.g. rotation was not taught in any detail unless pupils were working towards L6 and even then it was explored in all the primaries very briefly. The teachers interviewed pupils in year 11 who were L4 at the end of year 6 but were now identified as underachieving. Some of these pupils commented on the impact of setting arrangements. E.g. I don’t like setting. I think being with all weak pupils means I can’t work with or learn from my peers. This led the teachers to further explore with the group the opportunities in secondary in contrast with primary for pupils to work collaboratively, confidence with which they might share their weaknesses in understanding and how being in a particular set impacts on their view of their potential to succeed. Through the reciprocal visits the teachers also learned how kinaesthetic resources and games could be used with pupils who are struggling and how the focus for lower achieving pupils on entry should be on basic numeracy skills rather than launching into the traditional vast array of topics that are introduced in year 7.

St Mary Redcliffe and Temple School teachers agreed with the wider team that probability was not an aspect that we would include in detail in a transition policy. However there were aspects of curriculum coverage in transformations that it would be helpful for secondary colleagues to know. As with every other curricular area explored secondary teachers did not express a desire that primary teachers covered more or in a different way but rather they just wanted to have greater information on what explicitly was covered and for a limited number of areas e.g. calculation - what the expectations were for recording and how this was modelled. The teachers from St Mary Redcliffe and Temple School were also keen to explore how their year 7 curriculum and structure could be adapted in view of their findings and well as purchasing practical resources to target this group. Along with other schools they also felt further opportunities to develop the knowledge of their wider mathematics staff team regarding teaching approaches and models used in primary settings and especially around collaborative working would be invaluable in securing progress for target groups.

The key learning points for all schools were:

- Transition policy should include a summary of subject coverage and models for key aspects of the curriculum including calculation and specifically division as well as problem solving and contextual learning.
- Exemplification of the approach to calculation and problem solving and the associated expectations for presentation would be extremely useful in secondary settings in supporting high rates of progress.
- Exemplification tasks should be developed by primary and secondary teachers for pupils to complete in year 6 and to be placed in the front of their mathematics books in year 7 to support teaching and learning and to ensure consistent standards of presentation and achievement.
- Transition policy should include visual models that every secondary maths classroom should display to support the development of concepts.
- Collaborative discussion and practical resources can be adapted for use in all settings.

Through working with primary and secondary colleagues in a collaborative manner much greater understanding can be achieved in a relatively short period of time and it further supports the mutual respect in which each group holds each other even when there has been no previous experience of working together.

Impact on teachers’ practice

For all the participants there has been a commitment made to collaborative working in a cross phase manner. All the teachers have agreed to further develop the project, collectively produce materials and trial them this year. This is a huge step forward in terms of our learning as we now
understand what is required to develop our transition policy and approach and are well placed to achieve this having researched, explored and trialled approaches collectively and from a cross phase perspective. In addition for individuals in secondary settings there has been significant learning regarding the standards of work in primary school, the demands of attainment for pupils working at L5 and L6 and the extent of mathematical engagement of all pupils. This has led to personal reflection on how well matched year 7 lessons are in comparison across the ability range. The lead had not participated in such a project before and found the personal development opportunity challenging but also extremely rewarding on many levels.

Impact on others
We hope to secure impact of current year 6 pupils in their transition into year 7 by using the materials we will generate as a result of our findings. The collaborative group are keen to then extend this trial to other feeder schools and aim to secure city wide impact. The research based approach has been fed back via a Teaching School Alliance that four of the primaries belong to. It has been agreed that this should be a significant way of working to develop expertise across the Alliance and local schools and to ultimately develop professional development programmes and raise standards. It is very early in our work but it is hoped we can continue to work with Bristol University to explore this way of working. The headteachers from all the schools have sought feedback and are committed to developing the findings across their maths departments and year groups and developing the transition materials. In secondary schools several departments are considering re-structuring their year 7 curriculum especially for pupils working at L4c or below in response to the findings from the project. All the participating teachers will be invited to participate in a Widening Participation project also coordinated by Bristol University.

Advice to teachers who may want to try something similar
Managing a project that involved ten schools and nineteen members of staff was very ambitious. The number of participants rapidly increased from our original plans due to popular interest and we certainly did not want to curb enthusiasm and we gained a much richer range of data and perspectives given the larger group. However at the same time the practicalities of managing such a large group, especially for a very inexperienced lead, with schools that had not collaborated before, were demanding and certainly at the start were rather daunting. However we would advise leads and participants to embrace the challenge because the rewards and impact are certainly worth all the planning involved and the enthusiasm and commitment of the group made it much easier than was initially anticipated. Where sessions became difficult to manage it was usually where everyone was feeding back and we found this was most effective where a format was agreed in advance and the outcomes for each participant were made explicit. This ensured there was more of a structure and all viewpoints could be considered. It is also worth considering setting some limits on the areas of enquiry before beginning. As we were taking a research based approach we were careful to value all suggestions and almost try to cover every possibility. Although this gave us a huge amount of material, harnessing the discussion and learning became very challenging and perhaps less effective than if we had been a little more judicious at the start. Finally our project involved primary and secondary staff working cohesively and collaboratively. Unsurprisingly many colleagues in the schools doubted how well this would go and anticipated opposing viewpoints and stereo typical opinions. However this was far from true and as well as being a very effective group we were a harmonious one too. We would certainly recommend cross phase working to others!

References and resources produced or used