Collaborative teacher projects in mathematics: Teachers in charge

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There is some criticism in the mathematics education professional development literature that the majority of studies are designed and run by teacher educators and second that the voice of the teacher is not well represented. This paper aims to address this criticism by reporting on 49 funded research studies, requiring collaboration between at least two schools, but otherwise designed, conducted and reported on by teachers of mathematics. The paper explains how and why the studies were initiated and goes on to present the findings reported by the teachers in terms of their learning, changes in their organisations, changes in their practice and improved student learning. Although it is too soon to know if any changes are sustained, the reports suggest that overall the projects generated enthusiasm, energy and a real sense of having done something worthwhile.

BSRLM Keywords: Professional development; collaboration; teacher learning

Introduction

It is generally acknowledged that research into professional development for teachers of mathematics does not represent the voice of the teacher well enough; initiatives of professional development that are reported in the literature tend to be designed and run by, usually, teacher educators (Adler, Ball, Krainer, Lin, & Novotna, 2005). However, as the ICME survey into teachers learning and working through collaboration (Robutti et al., 2016) identified, many teachers are involved in formal and informal activities that lead to professional learning which are not represented in the literature. In many cases, teachers design their own initiatives, perhaps in response to an immediate concern such as children's difficulties with fractions or some accepted 'wisdom' related to good teaching such as maths mastery (as is currently the case in the UK).

This paper reports on a set of such initiatives which took place in the UK between 2012 and 2015. These initiatives were funded by the National Centre for Excellence in Teaching Mathematics (NCETM) which has supported teacher enquiry projects since 2006. These projects have the broad aim of stimulating a culture of action research and collaboration in schools and the findings from the first 96 of them were reported by Joubert and Sutherland (2010). The enquiry projects were replaced by Collaborative Teacher Projects (CTPs) in 2012; these were required to involve at least one school with evidence of the need to improve and to involve an "expert other" who could be a professional development leader, or a teacher educator from an HEI for example. They were further required to focus on mathematical proficiency in all schools, with a particular focus in primary schools on arithmetic proficiency. The funding for these projects was up to £5000 per project.

This paper provides an overview of the 49 CTP projects for which reports were available at June 2015. It then reports on the findings in terms of impact, framed by three key indicators, drawn from the work of Guskey (2002): teacher learning, changes in teacher practice and impact on students and others.

Overview

The CTPs all involved more than one school, and most involved more than two. Twenty-three projects involved only primary schools and eight involved only secondary schools. The remaining 18 involved both primary and secondary, typically a secondary school and a number of primary feeder schools.

The projects fell into three main types, those aiming to:

- Produce an artefact such as a calculation policy or resources to support teaching (19)
- Plan, implement and evaluate an intervention (a research study) usually in the classroom (12)
- Explicitly provide professional development for teachers, such as lesson study (18)

In terms of the mathematical focus of the collaboration, nine focused on fractions, four on algebra and two on division. Also included were, for example, number facts, number lines, 'little big maths', investigations and subtraction. Some did not state a mathematical focus but were concerned with improving the experience of a group of students, such as low achievers at the end of primary school.

For many, particularly in the first group listed above, the CTP was designed to address a particular issue. Two issues appeared multiple times: transition between different phases of schooling, and inconsistency in teaching approaches across different schools or even within a school. A third prominent issue was progression; teachers' lack of understanding of what has come before and what will come afterwards. Various artefacts (e.g. progression charts) were produced to provide guidance for teachers and schools.

Findings

The grant holders were provided with guidelines as to what should be included in the report. In particular, they were asked to state what had been learned, what impact there had been on teachers' practice, and what impact there had been on others.

Teacher learning

In terms of what had been learned by teachers, the majority provided some details, frequently mentioning, for example, something about mathematics and something about teaching mathematics.

Four reports discussed learning about *professional development*. They mentioned, for example, the importance of the role of the lead teacher, the value of involving the whole school (this particular project involved primary schools) and the need for a tight focus for the professional development. In a project involving secondary schools, the reported learning was that at least two representatives from each school should take part. In terms of the activities taking place during the CPD, two reports stated that they had learned how effective it is to work together to plan, predict, observe and evaluate, in contrast to 'merely observing'.

Some teachers reported that they had learnt about *mathematics*, with three saying that they had learned about fractions and two saying they had learned about algebra. Three also stated that they had learned about multiple representations of mathematical concepts.

Seven reports claimed that teachers had learned about *how children think about mathematics*. They stated, for example, how they now understood the students' current levels of mathematical understanding or how to predict where students might encounter difficulties. One teacher, for example, stated that 'The project has allowed me to explore exactly where children were encountering difficulties'.

Many grant holders reported learning about *teaching mathematics*. There were a number of general comments with at least five teachers reporting that they had become more confident as teachers of mathematics. Twelve teachers reported that they had learned about using, and planning for, different approaches, with three of these stating that they had learned the value of using 'rich tasks' and two others saying that they had learned that it is important to provide choice (in ways to approach calculations) for students. Three teachers stated that they had learned how important accurate and precise language is in the mathematics classroom.

Ten teachers reported learning in some way about teaching for understanding. Of these, five made general comments such as 'Even when children are fluent with calculation procedures, it is still important to engage them with thinking around why and how the methods they use work' and a further three stated that they had learned that they needed to give children time and not to rush them. One teacher, for example, stated: 'I can see very clearly now that I must give pupils time to think and break the problem down for themselves and not jump in to give the final answer or my own preferred method.'

Two other teachers said that they had learned about how to question students to check their understanding.

A large number (14) of teachers reported learning something about the value of using practical or concrete equipment, visual models and pictures. Whereas some reported learning was general, such as 'I have become more aware of the need to have more concrete materials available', others were more specific, mentioning, for example, paper folding and empty number lines.

A final set of learnings relates to *understanding curriculum expectations and school practices* at different levels. Fourteen teachers stated that they had learned about what is taught, and how it is taught, at primary/secondary level.

Impact on teachers' practice

In addition to grant holders writing about their learning, they were asked to report on how the project impacted on teachers' practice. The reported changes (40 reports) are presented below, grouped roughly into practice taking place a) outside the classroom and b) inside the classroom.

Outside the classroom

Thirteen of the reports stated that some sort of policy or guidance, almost all of them related to calculation, had been produced and were being, or would be used. As one report stated: 'The model calculations policy was introduced in school and there was immediate evidence of its use through lesson observations and planning scrutiny, due to its simplicity of format.'

In some cases there was some detail about the policy, such as one which is 'focussed on the use of manipulatives'.

The reports included eight comments to the effect that there had been an impact on teachers' planning. Some were general, such as a claim that teachers had begun to change their style of planning, and others included details such as paying attention to how students might approach a task; what the students would need to know before attempting a task; and 'connectivity within areas of mathematics.'

Some of the reported impacts on practice were in terms of teacher professional development. Two of these referred to teacher activity; one stated that teachers were now analysing their teaching and refining their practice and the other that 'teachers are now involved in deeper learning conversations and are looking more at research and pedagogy'. A further three authors stated that they had set up or led some kind of professional development, such as: 'I have led staff training focussed on misconceptions that might arise as a result of not having a balance between the conceptual and procedural understanding.'

Inside the classroom

More than half the reports claimed that their project had an impact on teachers' practice in terms of *the use of practical (concrete) resources, visual models, ICT and video.* It seems that in most cases, the use of these was something new, but in others existing equipment was revisited, as described in one report: 'It has stimulated teachers to 'dust off' the equipment that has been at the back of the classroom and 'have a go' at trying something different.'

Six reports explicitly mentioned concrete materials (also called practical or manipulatives), with most referring to these in general ways, such as 'practical equipment is now being used far more effectively to support the learning and embedding of children's knowledge, skills and understanding of number systems.'

Reports mentioning visual models include the use of number lines, thinking blocks, ten frames and bar models. Eight reports claimed that teachers' practice had changed to include use of these models, such as one which stated that '[t]he use of the number line and the connective model is now at the heart of teaching multiplication/division across the … Federation.'

In terms of ICT and video, one report stated that teachers were now using a visualiser 'effectively for the first time', and two others referred to video; one saying that video had been used to stimulate students and the other stating that students had produced 'video clips linking conceptual understanding and procedural fluency'.

Three reports made general comments relating to shifting teacher practice so that it becomes more learner-centred, with two suggesting that teachers were explicitly revealing and discussing students' misconceptions and one stating that the teachers were using 'kinaesthetic methods'. More specific changes related to allowing students time to explore, and teachers listening and watching, also giving them more responsibility for their own learning. One teacher, for example, stated: 'I spend more time allowing pupils to explore their mathematics observing their discussions with peers and ensuring when pupils come to a solution that they must be able to 'convince' another member of the group and not simply accept an answer.'

Six reports claimed that the impact of their project had been in terms of improved questioning, with one, for example, stating that 'questioning within lessons has become more focused and better thought out. Questioning is now used more consistently to deepen and develop understanding rather than solely to check

understanding.' One report referred to better use of examples, explaining that the teachers in the project now thought more carefully about the examples used in class.

Six reported changes in practice related to the use of tasks which require students to take responsibility for their own learning, such as open ended tasks and 'creative exploration of topics that would have been covered in a more didactic way previously.' A further three reports referred to the use of problem solving tasks within meaningful contexts. In contrast, five reports claimed changes in terms of teaching of calculation, with one, for example, stating that 'teachers have focused more on teaching calculations in class and have actually spent more time on this'. Another reported that 'number acrobatics', which uses games to develop fluency in calculations, was being used by teachers.

Finally, three reports claimed improved use, by teachers and children, of appropriate and accurate mathematical vocabulary.

Impact on others

Thirty-eight of the 49 reports claimed that the project had had an impact on *students*. Some comments were about students' attitudes towards mathematics, with four claiming that the students had become generally more confident in mathematics, such as the one who stated 'the 'fear factor' has been reduced and pupils are happy to have a go'. A further twelve claimed that their students now enjoyed mathematics or had become more engaged.

In terms of the students' mathematical learning, there were 53 separate comments. A first set (eight) concerned the development of confidence in specific areas of mathematics, such as calculation, proportionality and problem-solving. For example, one stated: 'pupils have gained in confidence when calculating multiplication and division problems … it appears that division remains a more challenging concept.'

Eleven reports claimed improved student understanding of mathematical topics, such as number and fractions. Some gave details about how the teachers knew there was better understanding, with one stating that the students made fewer errors and two stating that students were able to explain their thinking: 'The children seem much more able to clearly explain the steps they have taken to work out an answer, which shows a greater understanding.'

Other comments (19) claimed an impact on the students in terms of improved performance in mathematics. For example, one claimed 'the children have developed their mental maths skills and their understanding of number' and another that the project had a 'significant impact on the children's ability to use and apply methods accurately'. Some were specific, with one explaining that the children were able to use the Singapore Bar method and another that children were able to count on two, from five, rather than counting seven individual objects. Four comments were related to the use of mathematical language, such as:

> The use of correct mathematical language had an immediate impact on the students, as soon as the teacher was using the correct terminology e.g. integer, the children would quickly reciprocate this. Children would continue to use the correct vocabulary, at first when prompted, but then independently.

Ten further comments related to improved performance in terms of attainment in tests. A number of projects used tests, claiming that the project had an impact because students performed well (or, implicitly, better than expected) on these tests.

In one, the marks of the experimental class was compared to the marks of a control group, and the experimental class achieved higher marks.

Reports suggesting that there had been a *wider impact within the school*, referred to the whole school (primaries) and the department (secondaries). In primary schools (17 comments) the profile of mathematics seemed to improve, in terms of collaborative planning, motivation and the enjoyment of mathematics. One report, for example, stated 'It has also motivated the school as a whole to understand that maths can be fun to plan and teach whereas in the past it would be a less favourable subject'. Another explained that a model calculations policy had been introduced in the school and was already being adopted.

In terms of departments (six comments), some reports explained that teachers participating in the collaboration returned to school and shared ideas with the whole department. Some suggested longer-term impact, with one stating, for example, that the mathematics department would be 'keen to collaborate in the future'. Finally, one report stated that the project helped to 'springboard' collaborations between the schools in other departments: Literacy, Science, Art and Sport.

One report mentioned impact on *teaching assistants*, stating that they had 'received additional training to include the steps to learning' and two mentioned impact on parents, with one describing a meeting for parents and the other stating: 'Maths is regularly talked about and discussed not only in school but in homes of the pupils as well. This has generated parental interest and the schools have received positive feedback from parents.'

Concluding comments

This synthesis of the findings from the 49 reports provides strong evidence of the impact of the CTPs, mainly from the perspective of teachers. The teacher voice is clear, and the report begins to fill the gap in the literature identified above.

The reports were usually written very soon after the end of the funded collaborative project and there is no way of knowing how sustained the reported changes in practice (for example) might be. However, what is clear from the reports is that overall the projects appear to have generated enthusiasm, energy and a real sense of having done something worthwhile. In my view, even if the outcomes are not sustained for any length of time, taking part in the projects would for some, if not many, of the teachers, have been a life-changing event.

References

Adler, J., Ball, D., Krainer, K., Lin, F.-L., & Novotna, J. (2005). Reflections on an Emerging Field: Researching Mathematics Teacher Education. *Educational Studies in Mathematics*, *60*(3), 359–381.

Guskey, T. (2002). Professional Development and Teacher Change. *Teachers and Teaching*, *8*(3), 381–391.

Joubert, M., & Sutherland, R. (2010). *The NCETM Teacher Enquiries : Understanding the initiatives and their impact (Final Report)*. Sheffield.

Robutti, O., Cusi, A., Clark-Wilson, A., Jaworski, B., Chapman, O., Esteley, C., … Joubert, M. (2016). *ICME international survey on teachers working and learning through collaboration: June 2016*. *ZDM - Mathematics Education* (Vol. 48). Springer Berlin Heidelberg.