

## Understanding teacher enquiry

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The National Centre for Excellence in Teaching Mathematics funds teachers of mathematics to undertake small-scale enquiry projects. Underpinning this strategy is research evidence which suggests that involvement in teacher enquiry will have an influence on the learning practice of teachers. This paper reports on a study which aimed to understand the range and influence of these projects. The study found that the enquiry projects ranged in scope and focus, reflecting the wide interests and concerns of teachers and those involved with the CPD of teachers. Teachers reported that taking part in the projects had a positive impact in terms of their own learning, changes in their classroom practice and improved student learning.

### Introduction, background and theoretical framing

There is evidence in the literature on professional development for teachers that engaging in their own research has the potential to contribute to teacher learning (for example, see Jaworski, 2006, O'Hanlon, 1995, McNiff, 1995). It seems that the processes of taking a step back from day to day classroom activity to reflect, particularly on student learning, provides opportunities for teacher development:

The emphasis here is on reflecting critically and conceptualizing alternative perspectives on a problem, which ... lie at the very heart of professional development. (Atay, 2006)

The National Centre for Excellence in Teaching Mathematics (NCETM) subscribes to this view, and funds teachers of mathematics, in all phases of education from Early Years to Further Education, to undertake small-scale enquiry projects. Their hope is that taking part in these projects will benefit teachers in terms of their learning and, after funding just under 100 projects over a period of 3 and a half years, they were looking for evidence that such enquiry projects were having an impact.

This study (funded by the NCETM), aimed to investigate the scheme. It reviewed the NCETM funded projects (formerly Grants) scheme, providing a landscape overview of the teacher enquiries in terms of their organisational characteristics, using a framework based on the one developed for the Research Effective CPD in Mathematics Education (RECME) project (Joubert et al, 2009).

It also investigated the impact that involvement in such projects had on the learning and practice of the teachers who have been involved. Teacher learning is usually self reported and frequently (but not always) evidenced by changes in practice and sometimes improved student learning (Joubert and Sutherland 2008), although it is generally well recognised that an interrelated complex web of factors may also influence changes in practice and improved student learning. For example, changes in practice can be influenced by changes in policy and improved student learning in mathematics could be influenced by teaching and learning within a science classroom. However, we argue that, to help us understand teacher learning, it can be useful to investigate changes in classroom practice and improved student learning and we

framed our data analysis to include teachers' views on a) their learning, b) changes in their practice and c) their students' learning.

The research used three data collection instruments: an online questionnaire for grant holders; the reports submitted to the NCETM by grant holders; and seven case studies of practising teachers of mathematics who had completed an enquiry project.

The **questionnaire** aimed to gather information about a) the grant holder (e.g. professional role) b) the enquiry project and c) the respondent's perceived learning and experience. It was completed by 54 of the 96 grant holders.

The **reports** were used to provide details of the 'issue' the project aimed to address, the way the project was conducted and the results. Reports usually also included background information such as schools or colleges (and phase) in which the participants taught.

Seven teachers were identified from the questionnaire or reports for the **case studies**; a teacher working in an Early Years setting, two working in Primary schools, three in secondary schools and one in Adult Education (FE).

### **Landscape review**

96 projects were funded between Autumn 2006 and Spring 2010. Funding ranged from £1200 to £25,000, and projects lasted between four months and two and a half years. Projects were conducted by practising teachers (57%), teacher educators (23%) consultants (18%), and others (2%). They involved varying numbers of teachers with 20 involving fewer than 5 and 15 involving 16 teachers or more. Overall approximately 900 teachers were involved with the enquiry projects.

Within this period, enquiry projects fell into three types:

- **Enquiry interventions**, in which an intervention was put in place (e.g. more opportunities for practical work in mathematics) and was evaluated in some way;
- **Action interventions**, which initiated an intervention based on generally agreed 'good practice' such as setting up a network to support teachers of Further Mathematics;
- **Investigations**, which took the form of case studies or ethnographies, such as research into the relationship between teacher talk and student talk in algebra lessons.

For about 55% of the Enquiry Projects teachers were the subject of enquiry, for 19% students were the subject and for 26% the both teachers and students were subjects of enquiry. The major issues of concern included: a general aim to improve teaching and learning in mathematics (25%); making mathematics lessons more engaging for students (10%); raising attainment in mathematics (14%); addressing specific areas of mathematics (10%); and exploring models of professional development (11%). For four projects, the issue of concern was the transition of students from primary to secondary schools (4%). Other central issues included: Information and Communications Technology (ICT) (5%); assessment for learning (4%); Science Technology Engineering and Mathematics (STEM) (4%); teachers' knowledge and confidence (4%); special educational needs (3%) and leadership of mathematics departments (2%).

## **Teacher Learning**

We see teacher learning as related to mathematical knowledge in teaching (MKiT): knowledge of mathematics; knowledge of ways of teaching mathematics; and knowledge of student learning/understanding in mathematics. We also recognise that conducting an enquiry is likely to lead to learning which is broader than MKiT.

### ***Mathematics***

It was rare to find that teachers reported learning mathematics. Teachers who answered the question related to learning mathematics suggested that they had developed a better understanding of mathematics as a body of knowledge. For example, one teacher stated:

I suppose I've broadened my own understanding of what maths is. At times I think ... it all became about number ... I've relearned how broad maths is and how broadly ... or how much we use it. (Case Study 1)

Examples of specific mathematical learning included:

I read more maths articles from MiS, Mathematical Gazette and I think about how classic theorems can be moulded into classroom activities. (questionnaire response)

[I gained] new ideas about proof versus demonstration. (questionnaire response)

### ***Ways of teaching mathematics***

Almost 75% of the teachers who responded to the question about their own learning in MKiT reported that they had learnt about new approaches to teaching mathematics. The majority of these responses (41%) were related to more active approaches to learning mathematics:

I suppose that I was already convinced that changing to a less didactic approach would bring benefits, but along the way I have learned a great deal about how to effectively use those approaches in the classroom. (questionnaire response)

Reports from about 18% of initiatives implied learning about using different contexts for teaching mathematics, such as STEM contexts, and about 16% of the reports suggested learning related to the use of talk, discussion and group work in classrooms.

I learnt how important talking is in learning and that students need to construct their own knowledge - it is not something that you can 'give' them. (questionnaire response)

Other teachers suggested that they had developed better knowledge of the use of questions (13%) and the use of ICT in mathematics teaching and learning (12%).

Finally, there was a strong theme related to the idea of 'letting go', taking risks and allowing students to follow their own interests. For example, one teacher (see Case Study 1) suggested that she had learned about the importance of stepping back and observing the mathematical activity of her pupils, rather than teaching all the time.

### ***Students' understanding of mathematics***

A small number of teachers (about 10%) reported that they had learnt about students' understanding of mathematics. Many were unspecific; including comments such as

I know much more about how students learn. (questionnaire response)

Others were more specific, describing the areas in which they increased their understanding. For example:

I have learned more about children's understanding of ratio and proportion; and how they have problems with solving proportional reasoning problems. (questionnaire response)

Some explained how they were learning through encouraging their students to explain their methods or discussing problems areas and listening more to what their students were saying in the classroom.

I found listening to groups of students discussing in depth how they learnt mathematics absolutely fascinating and very useful. (questionnaire response)

Several teachers mentioned that they understood students' misconceptions better. For example, one teacher explained that her students' misconceptions '... are unearthed when students are encouraged to work things out for themselves starting from their current knowledge and to discuss their understanding and their methods'. (questionnaire response).

### ***Other learning***

About 10% of the grant holders who responded to the questionnaire reflected on the process of conducting an enquiry project. Some suggested that they had learnt about leadership. For example one teacher (see Case Study 6) said:

I learnt that it takes more time than envisaged to move staff from their traditional and safe way of doing things. (Case Study 6)

About a third of the initiatives investigated models of Continuing Professional Development (CPD), usually within an enquiry intervention with a mathematical focus. For example, one enquiry explored a collaboration between Year 6 and Year 7 teachers who reported that they had learned the value of working with teachers in another phase.

Several grant holders reported that their learning had been about CPD. Some reported that they had learned about working with colleagues in the role of a peer coach. Others said that they had learned to value CPD with a mathematics focus:

[I learned about] The value of subject-specific pedagogical dialogue. That this dialogue can be an effective form of professional development. That this dialogue can enthuse. (questionnaire response)

### **Changes in teachers' practice**

About 80% of the projects reported classroom change and the majority of teachers responding to the questionnaire said that their learning associated with being involved in an enquiry project had affected their classroom practice. The main changes reported involved approaches which moved away from teacher-led, textbook-driven lessons, towards more learner focused lessons characterised by 'active learning' involving group work, problem solving, rich open-ended tasks and games. For example, the teachers in all three of the case studies set in secondary schools (Case Studies 4, 5, and 6) reported that they now used a range of different ways to engage students using, for example, jigsaws, matching activities, extended tasks and practical work.

New approaches following the principles of ‘Assessment for Learning (AfL)’ and using ‘discussion’ were also adopted. Many teachers reported that they were now standing back more and letting their students work more independently.

I reduce my level of intervention when pupils are stuck so that they solve problems themselves. I use more non routine tasks and problem solving activities in the classroom.

Other changes related to the mathematical contexts used by teachers. For example, some teachers reported that they now used more real-life contexts such as finance, science experiments or working contexts (vocational students) to teach mathematical concepts. Teachers reported using ICT more both for whole class teaching (InterActive Whiteboards) and for student use (e.g. graphical calculators).

In the questionnaire, grant holders were asked to estimate the extent of changed classroom practice. Almost 60% of those who responded suggested that some teachers have made major changes and others have made small changes or none at all, with a further 36% suggesting that most teachers have made small changes.

### **Working with colleagues**

Many grant holders discussed changes in their practice in terms of changed ways of working with other teachers in their schools, with other teachers in their local authorities or with other colleagues. Very often this involved collaborating to plan lessons and more extended activities, frequently developing resources and strategies to support new approaches to teaching. In some cases it involved teachers observing one another in the classroom and jointly reflecting on teaching and learning.

I learnt about the power of working in teams and how structuring work in teams enables individuals to achieve more through the support that is built in through working in teams. (questionnaire response)

Four projects addressed the issue of transition between Key Stages 2 and 3 and in these projects teachers began to change their practice by working in various ways with teachers working in other phases. For example, one report described how teachers from Year 6 and Year 7 visited one another in their schools to develop a sense of what it might feel like to be a student in the different environments.

About a third of the enquiries involved a number of schools within a local authority and involved teachers from different schools in the authority. This meant that teachers worked with teachers from other schools in the local authority and they often reported that they found this experience valuable. As one teacher said (see Case Study 5), the experience had ‘Developed confidence in collaborative relationships between local schools.’

A small number of projects recruited teachers from wider areas than the local authority. One invited teachers from all over England to attend a summer school, and three worked with teachers in Initial Teacher Education (PGCE). Teachers reported that they valued working with colleagues in these settings.

### **Student learning**

Where initiatives focused explicitly on student learning (24% of 96 projects), evidence of improved student learning frequently took the form of attainment (65%). For example, one teacher (see Case Study 2) pointed to improved results in Key Stage tests:

This year we should have you know, in the 80s level 4+ but this should be 4B, 4As and we should have more level 5s as well. (Case Study 2)

Other projects (13%) reported improved student learning in terms of improved attitudes, for example stating that students now enjoy mathematics more, are more confident or more enthusiastic. For example

Students' attitudes towards tackling maths in this way made them more confident and independent. (questionnaire response)

About 22% of reported improved student learning was evidenced by different classroom activity such as more discussion.

I now use a variety of styles and activities in my lessons and the students do and say a lot more than they did - and a lot more than I do. (questionnaire response)

## Comments

The enquiry projects ranged in scope and focus, reflecting the wide interests and concerns of teachers and those involved with the CPD of teachers. There is clear evidence teachers perceived that taking part in the projects had a positive impact on their own learning, changes in their classroom practice and improved student learning. Teachers leading enquiry projects were able to try out new ideas and it seems that they were encouraged to reflect on their experiences both in terms of their own mathematical teaching and learning and in terms of the learning of teachers and students involved in the enquiry. We suggest that the process of writing an end-of-project report may have encouraged teachers' reflection.

Some enquiries took published research as their starting point and many other enquiries were grounded in accepted 'good practice' such as the value of collaborative planning and active approaches to teaching and learning mathematics. Reports which were explicit about their assumptions and the knowledge underpinning their approach were easier to understand.

The Case Studies revealed richer and more extensive data than was conveyed through the reports provided by grant holders. We suggest that case studies can provide accessible inspiration and exemplars for other teachers wishing to follow similar approaches.

Our view is that many reports produced by grant holders reflect a significant and worthwhile contribution to mathematics education in England and wider afield. We are concerned that some grant holders put a great deal of work into their projects but that their work is not well enough recognised within the wider mathematics education community.

## References

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