

Exploring effective professional development for teachers of mathematics

Findings of a research project funded by the NCETM

RECME

Researching Effective CPD in Mathematics Education



National Centre
for Excellence in the
Teaching of Mathematics

www.ncetm.org.uk

The RECME project

The study

The Researching Effective CPD in Mathematics Education (RECME) project was set up under the auspices of the National Centre for Excellence in the Teaching of Mathematics (NCETM).

The project aimed to:

- characterise different types of continuing professional development (CPD) for teachers of mathematics (to include both formal and informal experiences);
- investigate the interrelated factors that contribute to effective professional development for teachers of mathematics;
- investigate evidence of effective professional development for teachers of mathematics;
- establish the roles of research in professional development for teachers of mathematics.

The study investigated 30 initiatives representing different models of professional development for teachers of mathematics, in different locations of England, taking place in the academic year 2007/2008. Overall, about 250 teachers in pre-primary, primary, secondary, further and adult education settings were involved in these initiatives. The study investigated the organisation of the professional development initiative. Two 'focus teachers' from each initiative were interviewed and observed in their classrooms.



Courses offer opportunities for teachers to learn new things and to engage in deep reflection.

The professional development landscape

The initiatives studied in the project fell into three groups: courses, within-school initiatives and networks.

Courses

A course for secondary teachers based on ideas about Assessment for Learning

'It's so lovely to have time out of school to think and reflect, and to read. I've been shown all sorts of new resources and had time to investigate how to use them. Taking part has kept me motivated and it's taken me back to what I really like doing'.

One course, loosely based on the idea of Assessment for Learning, was run jointly by a mathematics teacher educator from a Higher Education Institution (HEI) and an advisor from the Local Authority by whom it was organised. The general aims were: to provide time for secondary school teachers to reflect; to encourage them to put their learning into practice in the classroom; and to enable them to engage with relevant research. Seeking to create a community in which teachers could meet, talk, share and learn from one another, course leaders set up a web page where participants shared resources, thoughts and ideas, in between and after the face-to-face sessions.

A course for primary teachers

Another course aimed to improve the quality of mathematics teaching in primary schools in one Local Authority. The teachers participated in eight day-long face-to-face meetings. It also gave them two days in their schools during which they could act on some of the things that they had learnt on the course, while other teachers took responsibility for their class.

During the course, Hannah said:

'...I am passionate about teaching maths and I see the difference in my attitude towards teaching maths and teaching other subjects. I really look forward to going on the course and I think incredibly carefully about my planning in maths'.

Within-school/college initiatives

A primary school working with a consultant

One headteacher, who wanted to improve attainment in mathematics as part of the school improvement plan, called in an outside organisation, BEAM, to lead professional development for all teachers in the school. The BEAM consultant collaborated with the mathematics coordinator to develop a programme. The programme ran throughout one academic year and included a number twilight sessions and some whole and part days.

Angela was one of the teachers at the school. She said

‘Everyone on the staff is doing the same things. It means we can share our experiences’.

Lesson study in two secondary schools

Two secondary school mathematics departments based their professional development on ‘lesson study’, where all teachers in the department collaborated to plan a lesson in detail. One teacher taught the lesson, sometimes observed by one or more colleague, and the lesson was video recorded. Later the members of the department watched the video, paying particular attention to the students’ responses to the mathematics, and adapted the lesson plan in the light of these responses.

Matthew, who led one of the initiatives remarked:

‘It gave us an opportunity to work collaboratively and to reflect on our teaching. It’s been good for the whole department.’

Within-school initiatives offer teachers opportunities to work together to embed new ways of teaching.

Networks

A network for teachers of young children

‘At the group meetings we share examples of our children’s mathematical learning supported by photographs, quotes, samples of work etc. Sharing our experiences adds to our collective knowledge of teaching mathematics’.

Teachers of the Early Years Foundation Stage at a variety of schools met once a term. The purpose of the meetings was to discuss new approaches to teaching mathematics to very young children which involve working from the children’s own mathematics. Teachers chose examples of children’s spontaneous mathematical problem solving and shared them at meetings, discussing the contexts in which they took place.

A network for FE teachers reduced isolation

‘I go to network meetings to meet other teachers and talk about our work. I feel isolated in my college.’

Mathematics teachers working in Further Education met once every term for a whole day, establishing a network which aimed to encourage sharing experiences, trying out new ideas and collaborative planning. Teachers collaborated in activities to explore approaches to teaching and learning. The focus was on using active approaches, more open questioning techniques and a variety of methods of assessment.

Networks bring teachers from different schools and colleges together to share ideas and knowledge.

The study showed that courses, within-school/college initiatives and networks provide different sorts of learning opportunities for teachers of mathematics. Teachers should be able to access the different sorts of professional development as appropriate.

Recommendations

Policy makers should:

- support the provision of a range of models of professional development;
- recognise that all teachers should have opportunities to experience a wide range of pedagogic approaches;
- provide support for teachers to take a lead in offering professional development for their fellow teachers.

Schools and colleges should:

- encourage teachers to take advantage of different kinds of professional development;
- support teachers in choosing professional development appropriate for their individual development and the needs of their school;
- provide time for participation in professional development activities within teachers’ contractual hours.

The NCETM should:

- identify and support teachers who could lead within-school initiatives;
- continue to provide support for existing networks and develop networks for teachers in all phases.

The mathematical focus of professional development

Teachers of mathematics taking part in professional development activities work on three aspects of mathematical knowledge for teaching: mathematics, ways of teaching mathematics and students' learning and understanding of mathematics.

Mathematics

'I really enjoy the way the course has been put together. I like the fact that we get to do some maths because it has put me back in the seat of the learner.'

In many initiatives, teachers worked on mathematics during the sessions. For example

- connections between graphs, equations and co-ordinates;
- calculus problems;
- fractions.

Working on A-level mathematics examinations questions



Teachers enjoyed doing mathematics and thinking about connections within mathematics. Some teachers found that working on challenging mathematics helped them imagine what it feels like to be a student, making them more sympathetic to students' needs.

Ways of teaching mathematics

Teachers usually discussed ways of teaching the mathematics they focused on in their session.

For example, in the initiative that worked on fractions (above), the discussion turned to classroom organisation and getting the children to work in groups, discuss their work and provide explanations for one another.

Within other initiatives teachers discussed mathematical concepts and ways of teaching mathematics. In one example, the group discussed representations of multiplication and the use of interactive ICT resources to support teaching of multiplication.

Initiatives promoted a variety of approaches, including: using extended activities that encourage deep learning; developing more teacher-led lessons; encouraging students to write explanations; setting students; encouraging more discussion about mathematics; the use of 'rich' tasks; and the use of more open questioning techniques and 'active' learning.

Exploring connections in mathematics



Which of these representations allow us to best reason the properties of multiplication

multiplication and division\Multiplication through arrays B.exe

Slide 31

Representations used in multiplication

Students' learning and understanding in mathematics

Teachers found it difficult to talk about students' learning and understanding in mathematics. In one example, a participant brought a video of one of his lessons. The teachers in the group were asked to watch the video, looking for evidence of student learning. Although the leader of the initiative reminded them to look for student learning, they only discussed the teaching. In other examples, when teachers were asked about the learning of their students, they provided general comments, usually not specifically related to mathematics, about what the students did such as 'they have good discussions'.

However, when teachers worked in cycles of deep analysis of mathematics, planning teaching, predicting, observing and discussing student responses to the teaching, they found it easier to talk about students' mathematical learning. Approaches included:

- using video of students' responses in mathematics lessons;
- teaching 'real' students in professional development meetings;
- finding ways to step back and observe students, making notes about what the students did, and then as a group, discussing their observations.



Observations of children's early mathematics

Reading research literature

'It is absolutely crucial to read research - of course it is. I have just given our GTP a copy of Skemp. I think it is important to understand about relational and instrumental learning. I also think the basic stuff around Constructivism is important. (email from a participating teacher)

Reading research developed teachers'

- awareness of different perspectives about teaching and learning mathematics;
- confidence about their own thinking;
- knowledge of new ideas to try out in the classroom.



Much of the research was directly related to the teaching and learning of mathematics, such as books on children's understanding in mathematics. Other research was more generic, and covered topics as diverse as special educational needs, young children's mathematical mark making, children's understanding of early number and research methods.

A number of the initiatives were designed to lead to optional Master's level accreditation. Examples of the focus of these include:

- developing potential subject leaders in secondary schools;
- using ICT in the mathematics classroom;
- mentoring mathematics PGCE students;
- assessment in mathematics;
- teaching and learning mathematics.

In Master's programmes, teachers read widely and reflected deeply on: the teaching and learning of mathematics; doing research; and on their own learning. They were expected to produce extended academic writing.

Research informing the CPD design

Some initiatives used research as a basis or a starting point for the focus of the professional development. For example, one initiative was based loosely on ideas from the research literature on 'Assessment for Learning' and another drew on the literature about ways of organising mathematics classrooms to promote understanding.

In some cases the design of the initiative was based on research literature on professional development. For example, some of the initiatives were informed by the ideas of Japanese Lesson Study, where teachers engage in cycles of deep analysis of mathematics, carefully planning a lesson, video recording the students' responses to the lesson, discussing these responses and reviewing the lesson plan in the light of the students' responses.

ICT in teaching and learning mathematics

Some initiatives addressed integrating ICT into the mathematics classroom. In one, teachers learnt how to use a handheld computing device and developed and shared ideas about how to use this in their teaching. In another, teachers collaborated to develop interactive web resources and then trialed them in their classrooms, discussing their experiences with the group at subsequent meetings.



Learning how to use the handheld devices

Recommendations

Research is needed to:

- investigate approaches to engaging teachers with students' conceptual development in mathematics.

Developers and providers of professional development should:

- include stimulating and challenging mathematical activities within the programme of professional development;
- include opportunities for teachers to develop knowledge about mathematics and ways of teaching mathematics within the professional development programme, drawing on relevant research;
- pay explicit attention to students' mathematical learning, possibly involving the use of relevant research.

The NCETM should:

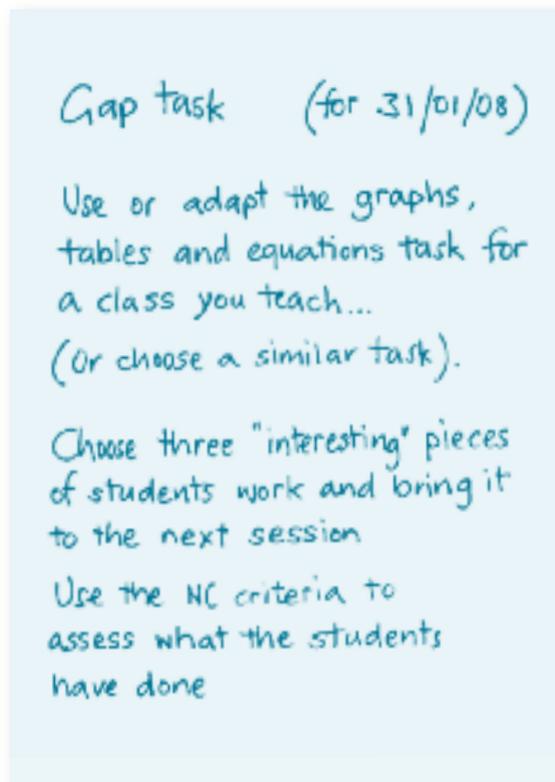
- develop tools to help teachers recognise and reflect on evidence of student learning.

Professional development and change: approaches adopted

Changes in practice

Teachers were sometimes expected to try out new ideas in their classrooms. For example, teachers of children in the Early Years Foundation Stage were encouraged to work with the children's own mathematics as opposed to taking a 'worksheet and textbook approach'.

In some initiatives teachers were given a 'gap task' to try out in the gap between the professional development meetings.



Some initiatives recognised that it might be difficult for teachers to make changes and provided support. For example, one leader suggested that participating in a programme of professional development gave teachers 'permission' to try new ideas or by providing help in the classroom.

In many cases, teachers reported back to the rest of the group after trying out new ideas. Some reflected on the trial in a journal.



Reporting to the group after trying out a new approach



One initiative provided structured reflective journals

Embedding change

Some initiatives supported teachers in embedding approaches they were already using, rather than asking them to try new ideas. For example:

- developing sharable resources to support teachers in using new kinds of mathematical classroom tasks
- discussing experiences of embedding an approach in which students were asked to write down mathematical explanations on index cards
- providing ideas and resources to support active teaching approaches in mathematics.

In another initiative teachers were encouraged to try using new 'rich' tasks which involved the students in working on tasks that were less well-defined than they were used to. One of these tasks involved investigating tessellation and a second involved investigating reflection and rotation.



The students in this class were using materials to support active learning approaches



The teachers discussed the explanations students had written on index cards

Tessellation display resulting from a 'rich' task

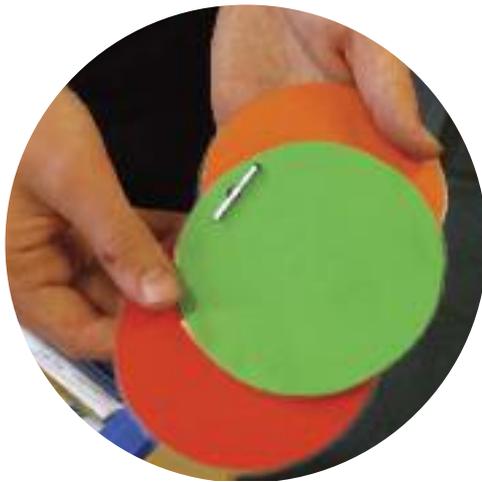


Professional development and change: teachers' perspectives

Many teachers reported that, since taking part in the professional development programme, they had changed their classroom practice.

- Some teachers described how they used ICT much more in whole class teaching.
- Others reported that they had started using rich investigative tasks.
- One teacher had started using a 'red, amber, green' system with her Year 5 class for the children to indicate 'yes, maybe, no' to some of her questions.

A student holds out the 'red, amber, green' traffic lights she uses in mathematics lessons



Many teachers said that their teaching had improved. Some said that they allowed their students more control over, and input into, lessons or that they now put the students' needs first. For example, Caroline teaches numeracy to adults and she explained how she now puts the learners' needs first, by tailoring the tasks she sets for her learners to meet their needs and interests. In one classroom session, she suggested that Jenny and Nadine work together on fractions. She said she had worked on their assessments and saw that they both had 'glitches' on fractions. She encouraged them to talk to each other to make sure that each understood as they went along. Others were working on the problems she had handed out. Louise asked Caroline for some work on formulas, because she was due to take her Level 2 test soon and wanted some practice in algebra.

When questioned, teachers reported improved student learning by referring to students' work, what students said and improved attainment.

'Children are now more able and willing to explain their thinking.'

'The majority of the children really looked critically at the information and had some really good comments about the graphs ... we have fewer children who just sit looking at a blank page when they are faced with problem solving and now they know they can have a go and it doesn't matter if they make a mistake because you can learn through making mistakes...'

Teachers often reported that students' attitudes had improved. They said that students were more willing to:

- share knowledge and collaborate
- engage in discussion and communication about mathematics
- persevere in tackling difficult tasks.

Teachers said that the atmosphere in the classroom had improved and that their students were more confident and motivated.

'My class love numeracy. They enjoy and develop their numeracy skills within a playful, practical and challenging environment.'

'Students on the whole enjoy their maths lessons more which means they are better behaved and more attentive'



Children discussed their work in mathematics more readily

Recommendations

Developers and providers of professional development should:

- encourage teachers to try out new ideas in the classroom by giving them 'permission' to do so;
- build adequate time into the programme for teachers to try out new ideas and reflect on their learning.

Schools and colleges should:

- support teachers in trying out new ideas for teaching and learning mathematics;
- support teachers in embedding approaches they are beginning to adopt.

Effective CPD

RECME focused on two key questions:

- What factors contribute to effective CPD?
- What evidence is there that CPD was effective?

What factors contribute to effective professional development?

- Teachers have time to stand back from their day to day practice, to engage with new ideas and to reflect on their practice, their own learning and their students' learning.
- Leaders of professional development initiatives are well-informed and knowledgeable.
- The activities and ideas in the programme are relevant to the teachers' practice.
- Schools, colleges and students are supportive, particularly when teachers want to try out new ideas in the classroom.

Some of the best teacher learning takes place when the CPD addresses all aspects of mathematical knowledge for teaching, engaging teachers in cycles of deep analysis of mathematics, detailed planning, predicting student responses and discussing actual student responses.

Research often plays an important part in developing effective professional development: it informs the structure and organisation of the programme; it provides relevant material for the teachers to engage with; and it serves as a basis or starting point for the programme.

What evidence is there that professional development was effective?

Much of the evidence that professional development was effective came from the teachers themselves, who described their own learning in terms of:

- increased awareness;
- improved knowledge in mathematics and ways of teaching mathematics;
- improved attitudes and motivation.

They also reported on changes in their classroom practice and changes in the students' classroom activity, describing improved attitudes and increased motivation, and sometimes suggesting improved student learning.

Other evidence came from the observations of the research team, who visited teachers in their classrooms and noted that classroom practice was in line with the approaches advocated by the professional development initiative in which they were involved.



Moving forward: find out more

- To find out more about the RECME findings, read the full report which can be downloaded from the NCETM portal www.ncetm.org.uk/recme. The case studies within the report can also be found on the portal.
- If you want to become involved in mathematics CPD, you can find out about more about what is available on the NCETM portal www.ncetm.org.uk/cpd
- If you would like to read about other NCETM research and teacher enquiry visit the 'Enquiry' section of the portal www.ncetm.org.uk/enquiry
- The self-evaluation tools on the portal provide a good way of taking stock of your own knowledge and understanding www.ncetm.org.uk/personal-learning