Researching Effective Continuing professional development in Mathematics Education (RECME) Findings: professional development and student change

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This paper presents some of the findings of the Researching Effective Continuing professional development in Mathematics Education (RECME) Project which was set up to investigate, amongst other things, the role of research in 'effective' CPD for teachers of mathematics. It is generally agreed that changed student behaviour and more particularly improved student learning is the ultimate goal of professional development for teachers of mathematics. The focus of this paper is on some of the findings of the RECME project in relation to student learning. The paper gives examples of the ways in which involvement in the professional development initiatives encouraged teachers to talk about student learning. The implications of these findings for designers of professional development opportunities for teachers are discussed.

Student learning, professional development,

Introduction

The RECME project (Researching Effective Continuing Professional Development (CPD) in Mathematics Education) was a major research project funded by the National Centre for Excellence in the Teaching of Mathematics (NCETM). The project investigated thirty continuing professional development (CPD) initiatives in mathematics education from all phases of education from early years to further education. The RECME project involved a team of five researchers from a variety of research backgrounds and used a range of research instruments which provided a rich data set of qualitative and quantitative data. This data included observations of professional development sessions, interviews with teachers and classroom observations of their teaching of mathematics and also an online questionnaire.

The overarching question of the project was concerned with identifying the interrelated factors contributing to effective CPD, a central factor of which can be seen to be improved student learning. This paper focuses on reported improved student learning.

Background

Improved student learning in mathematics can be seen as the ultimate goal of CPD for teachers of mathematics (see, for example, Guskey, 2002). We agree, and we consider that it is important for teachers to be able to identify and articulate improved student learning because we believe that, in doing so, teachers are empowered to take a step back from their CPD to question whether any changes in practice that are suggested to them, and that they try out, might be effective.

We acknowledge that recognising and talking about student learning is difficult. However, we suggest that there are approaches initiatives of CPD can take to provide teachers with tools to do so, and in this paper we discuss some of approaches

we observed and the ways in which teachers talked about their own students' learning. We are also able, in some cases, to triangulate the teachers' claims with our own observations of the teachers' lessons.

Approaches to thinking about student learning in different CPD initiatives

In some of the CPD initiatives we investigated, consideration of students' learning was addressed by engaging teachers with tackling mathematical tasks themselves before considering how their pupils might respond to them. They were then encouraged to try the task with their own pupils and reflect on the responses that the pupils made to them before bringing those reflections back to a subsequent professional development session and sharing their observations and reflections with their peers. This enabled the professional development to engage with the teachers' own subject knowledge, consider approaches to teaching specific topics and also to reflect on students' understandings and ways of coming to know the topic.

An example of this approach comes from a course for teachers that was run by a local authority and enabled teachers to gain Masters Level accreditation through the submission of coursework and a written assignment. The course was for primary teachers and in the observed session, which was on the topic of fractions, one of the tasks involved the teachers in ordering three sets of fractions in order of size. The sets of fractions were:

2/5, 9/5, 4/5, 10/5, 5/5
6/3, 6/8, 6/4, 6/12, 6/7
7/8, 10/11, 3/4, 8/9, 4/5

In response to the task, teachers drew a diagram to illustrate each fraction and discussed and expressed in writing the reasons for their ordering. This involved the participants convincing one another of the validity of their mathematical reasoning. The task involved all the teachers and generated a lot of discussion and mathematical reasoning. In the observed session, this task and other related tasks raised and addressed some of the common misconceptions about fractions. The discussion covered the implications for individual teachers' practice in their schools, as well as more general issues related to curriculum content and organisation.

The organiser said that the intention was for the teachers to consider pupils' learning as a result of their engagement with the suggested tasks and to feed back their observations at a subsequent meeting. This claim was substantiated by observations of the practices in the meeting in which the teachers brought with them examples of the work that their students had done on the previous topic which had been using ICT to support mathematical learning. They had made detailed observations about these examples and engaged in careful consideration of the ways in which various approaches had supported their students' mathematical learning. So they were involved in a cycle of looking carefully at mathematical activities and predicting their students' responses to them, trying them out with their students and observing their reactions and responses, reflecting on these responses before offering feedback to the whole group at the next meeting.

Another whole department secondary school initiative followed a 'Lesson Study' model. The lesson study approaches we observed were based on Japanese Lesson Study and followed the model to a greater or lesser extent. In all, teachers collaboratively plan a lesson, one of the teachers teaches this lesson and is videoed, and then the group discusses the video. The lesson plan was iteratively developed. This 'lesson study' initiative is described more fully in Case Study 4 of the RECME

report (p.48) (Joubert et al, 2009). It used a similar approach to engaging with student learning to that of the primary initiative described above in which teachers were encouraged to predict student reactions to mathematical tasks they were given, to observe in minute detail how the students responded and then to reflect on the student responses within the group. The teachers were engaged in developing a lesson introducing high attaining Year 9 pupils to the idea of factorising quadratics.

During the development and the presentation of the lesson, the teachers involved were given time to observe students' learning, both as teacher and observers. After observing and participating in the first lesson trial, their discussion focused closely on shifts in their awareness of their pupils' learning and ways of developing their learning.

Another approach to considering students' learning came through shifting the focus of the teachers' teaching to the learning of their students through offering students learning opportunities that would give the teachers more time and opportunities to observe student learning. In one such whole school primary initiative this approach was one of the principle foci in an initiative that also involved a move away from textbook and worksheet led mathematical activities.

Another initiative which involved a network of Early Years practitioners focused on opportunities for mathematical learning that children initiated for themselves and ways of working with the pupils that triggered and supported these children's mathematical thinking and reasoning. Meetings focused on sharing accounts of the children's mathematical activity through the presentation of narratives and examples of children's recording of their thinking. In the observed meeting the focus of the examples that were shared was of examples of children's spontaneous mathematical problem solving and the teachers recounted examples that had been triggered by a wide range of different stimuli. One example involved a girl making a paper chain with loops of paper linked together. The child wanted to make a chain that would be the same length as the width of her desk and tried to estimate. This proved tricky so she created a 'tape measure' from a long strip of paper with numbers in order from 1 to over 30. The teacher described her involvement with the problem and the mathematical reasoning with which she was engaged.

Teachers' evidence of improved student learning

When teachers were asked about improved student learning, the majority of teachers provided generic descriptions, usually of improved motivation or changes in classroom behaviour. For example, one primary school teacher commented that: 'Children are more able and willing to explain their thinking.' Another teacher also spoke in general terms about changes in her students and their relationship with her practice:

> Children are now more able and willing to explain their thinking. We make sure we do investigations more now and getting the children to be more analytic and explain what they have done rather than just to say 'I just knew it'… I've always thought it is very important to be very practical doing maths and that's why it excites me: it's given me licence to do it…
>
> A lot of the thing is that children need skills in order to investigate and there is a balance between getting the skills and making it meaningful. And the question is, can you teach some skills through investigation?

This comment illustrates the teacher's reflection in relation to her teaching practice and this was common to many of the responses that we received. It also suggests that this teacher felt that her involvement in the professional development initiative had given her permission to change her practice to a more practically based and investigative approach.

These examples suggest that the teachers found it very difficult to talk about changes in student learning and had a tendency to offer us generic examples that focused more on changes in behaviour and overall changes in confidence.

Despite the dominance of generic descriptions of student learning, there were some instances in which the teachers cited examples of evidence of mathematical learning and some of these were substantiated by observations in the lessons that were viewed.

For example, one of the teachers involved in the lesson study example above offered the following written observations he had made of improved learning:

> The evidence for change is my own personal observation.
>
> For example:
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> At the end of a lesson a girl who has struggled with a new idea saying 'Oh! I get it now' – a 'wow' moment. Perseverance leading to learning.
>
> Asking students at the beginning of the lesson: 'Do you know how to solve problems of this sort?' (and maybe a couple say yes) by the end they are all solving those problems.
>
> Giving an open starting point pupils independently pursuing 2 or 3 different lines of enquiry and then explaining their investigations to each other.

A lesson observed from the same initiative, focused on a consideration of the subtraction of fractions and led the students towards the subtraction of algebraic fractions so that by the end of the lesson, one girl was able to explain to the other students that the solution to x/3-x/4 was x/12. She did this very clearly offering clearly justified and reasoned steps for a detailed solution and answering her peers' questions with clarity and precision. This was evidence of one student's learning that was sufficiently secure for her to act as teacher to her peers and this approach was frequently used by the teacher concerned. He had developed a classroom culture that involved co-operation and collaboration amongst his students and in which there was strong evidence of pupils actively engaged in learning mathematics and interested in and committed to the process of doing so. Pupils spontaneously wandered round the room to help others who were stuck and the talk in the classroom was focused on the mathematics they were working on.

In another example, a further education tutor working with adult students on basic numeracy skills offered us evidence of student learning in the form of comments her students had made to her about their improved mathematical skills. Four of her students said:

> Someone asked me a question and I could answer it.
>
> I was listening to the radio and heard a GCSE question and I could answer it!
>
> I could give the bus driver the right money.
>
> I still don't like maths but at least I can do it now.

Other teachers reported connections that they perceived between the changes in their practice and improvements that they had observed in their students' leaning of mathematics. One such example came from a further education tutor who had

supported a young adult student in developing her understanding of money. The student had complained to her that her mother was always cross with her for not being given the correct change when she went shopping. The tutor described how she had got out the play money and marked up different amounts on labels in different ways so that the group could 'play' shopping. A few weeks after this the student in question had come back to her tutor very pleased with herself as she had checked her change, found it was wrong, confronted the cashier and had it corrected. The tutor felt that the practical approach she had adopted with the students had supported this learning. One teacher from the primary school initiative above commented:

> I think children learn better through practical activities and you have to have them there for them to see what best fits the children. It is not a case of just opening up a page of maths and doing pages and pages and they understand. It's about doing some examples and practical tasks and giving support where and when it is needed, then, if there are misconceptions, you are there to clear them up.
>
> I use more activities, far more resources and practical activities. Now if people were working practically and they didn't have written evidence of their learning, that wouldn't worry me. I don't feel that a child has to write something down to know it.

The same teacher also commented on making observations of the children's learning on PostIt notes during the course of the lesson which she was now more able to do as the students were working more independently of her during the lessons. She still saw herself as the supporter and facilitator of her students' learning, as the quotation shows, but they were better able to gain support from one another and the practical apparatus available to them than had previously been the case.

We visited the Early Years teacher who talked about the paper chains (above). The example she had described was displayed as a poster with an account of the event and photographs of the sequence of events. This deep engagement with the processes of mathematical thinking and its focus on observation by the teacher was strongly evident in the activity of this network of teachers. They related their observations to research writing about children's early mathematical mark making activity and development, particularly the work of Carruthers and Worthington (2003).

Effects of shifting attention

From our evidence it would seem that, although teachers find it difficult to shift their focus onto their students' learning and away from their teaching, when they do so it has a significant impact on their practice and makes them more aware of the opportunities that they, as teachers, can offer for mathematical learning. The teachers involved expressed a sense of space and a release from the busyness of classroom activity that their change in focus had led to. As one said:

> Now I am much more of a researcher-teacher of maths. I spend more time sitting back, refraining from teaching and taking time to figure out what the students are learning and to understand more fully what they are thinking.

This excerpt seems to encapsulate the idea of the reflective teacher practitioner which it was the intention of many of the initiatives that we observed to foster.

Concluding comments

We have described some of the approaches CPD initiatives in the RECME sample took in order to encourage teachers to think about their students' learning. We have also provided some examples of the evidence of improved student learning provided

by the teachers. It seems to us that where initiatives explicitly focused on student learning, the teachers were more able to discuss their students' learning. Teachers who gave accounts of changes in practice that they reported as sustained and profound had often been involved in their CPD in focusing on student learning. They had also been involved in reflecting on the relationship between student learning and their own professional practice in the classroom.

What are the implications of these findings for designers and leaders of professional development opportunities for teachers of mathematics? We argue that a focus on the careful examination of students' learning of mathematics and their responses to mathematical learning opportunities offered to them can have a significant effect on the development of reflective practice amongst the teachers involved.

References

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