PGCE STUDENTS' PROFESSIONAL CHANGE THROUGH EXPERIENCES OF PROBLEM SOLVING

Peggy Woods and Nick Pratt

University of Plymouth

Abstract: This article reports on a small scale study in which PGCE primary students were asked to record and report their experiences of mathematical problem solving during school placements. We comment on these experiences, but also on how the involvement in the project was important in helping students to construct new ideas about effective maths teaching more generally.

INTRODUCTION

It is clear that Problem Solving in mathematics has long been an issue for policy makers and practitioners alike with the National Curriculum (DES, 1989) and, prior to that, the Cockcroft report (DES, 1982) advocating that 'the ability to solve problems is at the heart of mathematics' (para. 249).

In this paper we explore how a group of Primary PGCE students developed meanings for mathematical problem solving through the way they experienced it during their ITE programme. The research questions leading the project were:

- What are the experiences of PGCE primary students in relation to mathematical problem solving?
- How do the faculty-based and school-based aspects of these experiences inter-relate?
- What do these experiences tell us about mathematical problem solving in schools?

In particular, we consider the ways in which this development was affected by the interaction between faculty- and school-based experiences, and how new meanings for problem solving prompted students to (re)construct ideas about mathematics as a whole, in a reciprocal relationship.

METHODS

The entire 2005/6 cohort of seventy students on the Primary PGCE programme at the University of Plymouth was invited to take part in the research project. Fourteen of them elected to do so – the self selecting nature of their participation being significant to our findings. Of the programme's thirty-eight weeks, eighteen are spent on school placements and twenty in faculty. The research project consisted of three phases; each one involving the students being asked to look for examples of mathematical problem solving happening during their school placements and reporting back on their findings during interviews with the researchers on their return to faculty.

In the first phase, after three weeks in school during the Autumn term, students were invited to describe and analyse their experiences, observations and ideas in group

interviews. These were taped, transcribed and analysed, leading to the identification of several initial themes. In the second phase, the students were again asked to look for examples of problem solving during a six week school placement (Spring term), this time being provided with a structured pro forma which focused on the themes identified in the initial phase. A second phase of group interviews in faculty followed this placement and the process was repeated for the final ten week placement which took place in the Summer term. The data collection concluded with paired interviews of students following final school experience at the end of June. It is worth mentioning here that although the researchers did not offer students their own interpretations of mathematical problem solving at any time during the interviews, in another capacity the researchers were working with the students as mathematics tutors on the programme.

In analysing the data, use was made of Wenger's (1998) model of a community of practice, the 'community' in question being seen as at the level of 'teaching professional' with student teachers working alongside (school-based) 'experts' in the field in an apprenticeship role.

DATA ANALYSIS AND FINDINGS

Analysis led to a growing awareness of a number of commonly raised, inter-related themes concerning mathematical problem solving in particular, but also concerning the way in which student teachers developed new models of mathematics and of teaching *through* this consideration of problem solving. Space prevents a full explanation of all three and the findings relating to the first are presented in outline only.

1. What the students marked as significant in terms of classroom/school practice (outline of findings)

Students' accounts of their experiences marked out certain common ways in which they perceived schools and individual teachers to be interpreting problem solving. To a large extent these could be seen to reflect messages implied in national strategies and related to the following aspects of practice:

- Problem solving was seen as a distinct aspect of mathematics, a content strand, on a par with measurement or calculation, say. As such, it was relegated to particular time slots (often on Fridays).
- Problems were often used at the end of a unit of work in order to see if pupils had 'understood' the content of previous lessons – i.e. as an assessment tool, reflecting an un-situated, 'acquisition and application' model of learning mathematics focused on 'basic skills' (Kelly, 2006a).
- Mathematical problem solving was understood as 'calculations in words or word problems'. Solving these tended to be more of a linguistic exercise than a mathematical one (Frobisher, 1994).

- Asking children to explain how they worked out calculations, almost exclusively those involving **number**, was another common view of what constituted problem solving.
- Students' experiences tended to reflect classroom interactions that were: teacher controlled with predetermined learning outcomes; usually focused on mathematical content rather than process; and emphasising pace rather than reflection.
- The physical context afforded and constrained how problem solving was constituted. Large classes and lack of space were commonly reported factors, as was inflexible use of unit plans and schemes of work.

2. Who can do mathematical problem solving?

Students' accounts suggested a common theme concerning who, in the class, would be most likely to be successful in solving problems. This theme had two interrelated strands: the **age** of the children and their perceived **ability**. In terms of the latter, students' developing constructions of both 'ability' and 'problem solving' appeared to influence each other strongly. Problem solving was often seen as an aspect of mathematics only appropriate for the more able pupils, for example:

> RS: The whole class was split into four groups, one top, two middle and one bottom set and they were all really quite different in ability. The top set, occasionally, would be given investigative type work.

Similarly, when asked to describe problem solving situations students commonly described ones where they had been working with the 'more able pupils' (Houssart cited in Nickson, 2003). Simultaneously, some of the students reflected the practice they had experienced in school suggesting that problem solving was not appropriate for younger pupils as they had not yet 'learnt' enough content (again reflecting a basic skills model of acquisition-application).

> DC: So it [Year 1] was very basic, putting numbers into sequence was as far as they got really and adding 1. The top number of the group could subtract 1 but there was no way we could relate it to anything that was problem solving.

Lower achievers were rarely encouraged to work independently and many of the students expressed concern in the light of such practice. During the last phase of the project in particular they began to question what might define 'being good at school mathematics'. This, in turn, prompted them to consider the nature and purpose of the learning process.

> HK: The other observation is that therefore Jack actually comes out [to the board] and everyone says Jack is the mathematician because he's good at doing the calculation. Whereas the teacher is frustrated with Claire because she is apparently underperforming, but perhaps that's because she is not actually being asked to think. If she's stronger at being conceptually mathematical rather than procedurally mathematical, she won't shine.

3. How were students' developing ideas about mathematical problem solving affected by their stories of significant events?

The project, as it was constructed by us as researchers, put problem solving at the centre of students' attention (in relation to mathematics) during and after their school experiences. As a result, students could not help but view problem solving as being highly significant in respect of mathematical work in schools – problem solving was constructed as 'a good thing' *per se* by the project itself. In light of this it was unsurprising that there was a strong association between situations in which students reported a 'feel good factor' and their tacit definitions of problem solving. For example, below, JM describes how he involved children in creating their own problems and how this had generated talk and engagement with the task.

> JM: Having them talking about it and really doing it, I was thinking wow this is good. This is the way I want my maths to be going. Not every day, but at least one or two days a week where the main activity is talking about a question and one kind of issue, as opposed to practising.

When giving his account of the lesson his enthusiasm indicated that the incident had been critical in determining how he wants to teach mathematics. For HL, personalising problems for children seemed to engage them in a new way.

> HL: So I personalised it and put their name in it … As soon as you put their own name in it and they could say whether it was sweets or dolls or whatever, they switched on immediately. It was quite a revelation actually. Giving them the opportunity to make up their own problems with their content. Then they switched on; they turned around quite remarkably. That was a strategy I will use in the future.

Students' references to their own experiences of mathematics, to what worked for them as a learner of mathematics, was also important in influencing their understanding of the subject and how it can be learnt.

> SJ: I always kind of relate it to real life problems. To me, it was always about things like money, solving how far we've got to get. You know the word problems I was talking about before. So that's how I perceive it to work.
>
> LS: Probably because I'm quite competitive myself. So I always enjoyed playing games……. So it's funny how I'm putting into what I would have loved when I was in school……. But that's always the way I've had in my mind. That's the way I wanted to teach. Not just for maths but for literacy as well and for everything. I don't want for them always to be writing down.

CONCLUSIONS

In returning to the research questions which led this project, our findings in respect of **practices** seen in schools hold few surprises given the tightly controlled and inspected nature of recent curriculum changes, and for the purposes of this paper we do not wish to elaborate on them.

What has been of most interest to us though is the way in which the project appears to have influenced the participants' developing thinking in relation to the nature and purpose of mathematical problem solving in particular, and to experiences of learning mathematics generally. In seeking to explore the state of mathematical problem solving through the eyes of our students we provided them with a forum for discussion and reflection which has not previously been provided on the programme. Consideration of the role of problem solving in children's learning of mathematics as they experienced it in school settings led the students to begin to re-evaluate their understanding of what 'doing mathematics' might mean. This, in reciprocation, led them to re-negotiate meanings for mathematical problem solving and of what it might mean to be 'good' at school mathematics. This cycle of reflection-on-practice (Schon, 1987) afforded students the opportunity to articulate their identification, both *with* particular practices and *as* particular kinds of practitioner (Wenger, 1998).

Our practice as a teaching team in the past has been to promote the view (like Cockcroft) that problem solving is at the heart of mathematics. More particularly, we have tried to portray mathematics as fundamentally *about* identifying mathematical opportunity in situations – 'seeing the world through mathematical eyes' (Solomon, 1998). This takes place not just through explicit teaching, but largely through the way in which we present mathematics to the students and the nature of the activities they engage in as part of the faculty-based element of the programme. For some students this approach has been constructive. However, it has been very much dependent on the opportunities they have had to explore teaching approaches during school placements and, most importantly, the manner in which previous experience positions them in relation to the subject. For most students we have long recognised that the impact of the faculty based element of such a short programme is often not as strong as the impact of the school based element of the programme. The difference for the students participating in this project was the opportunity it presented for them to tell their own stories about their school-based experiences and to listen to the stories of other students. In this respect, the 'research' and the 'learning' cannot be separated. Also of importance was their autonomy in choosing to engage in the project in the first place; in contrast to many activities in teacher training which tend to involve requirements to comply with superficial versions of teaching expertise involving regulations and 'tick box' evidence bases. As Kelly (2006b) has argued, forms of teacher development involving 'reflective, discursive, collaborative and inclusive' engagement are more likely to help teachers (trainees and more experienced) to develop 'deep' knowledge-in and knowledge-of practice which will prove more useful to them in the future.

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