A study of primary student teachers' mental calculation strategies

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Ten years after the introduction of the National Numeracy Strategy, in a major review of the teaching of mathematics in Early Years settings and primary schools, Williams has called for a refocusing on oral and mental maths in order to particularly benefit under-attaining groups of children (DCSF 2008). One major aspect of this 'oral and mental' area of mathematics is for children to know a range of mental calculation strategies and be able to choose and use the most effective method for any given calculation (DfEE 1999). In this paper I discuss the findings of an initial pilot study into the strategies used by five student teachers, and the impact of my intervention on their practice in school.

Keywords: Primary, Students, Mental

Introduction

> 'Recommendation 10: This review recommends a renewed focus by practitioners on 'oral and mental mathematics'. Providers of ITT and CPD should ensure that this practice receives careful attention, both during ITT and in CPD programmes.' (DCSF 2008, 66)

The introduction of the National Numeracy Strategy (NNS) Framework (DfEE 1999) brought together recommendations (e.g. Plunkett 1981, cited in O'Sullivan et al 2005; DES 1982) to improve children's mental calculation strategies. The Framework suggested that a designated time each day, usually at the beginning of the 'numeracy hour', should be set aside to rehearse and refine these skills. Ten years later, in a major review of the teaching of mathematics in Early Years settings and primary schools, Williams has called for a refocusing on oral and mental mathematics in order to particularly benefit under-attaining groups of children (DCSF 2008). The recommendation shown above states this clearly. One major aspect of this 'oral and mental' area of mathematics is for children to know a range of mental calculation strategies and be able to choose and use the most effective method for any given calculation (DfEE1999). If this is the case, how are we preparing the new generation of teachers to successfully enable the children to learn these skills?

There are numerous reasons for this need to improve mental calculation skills and strategies, some of which will be considered later. My concern is that our current student teachers may not have these skills themselves, so how can we expect them to teach this fundamental area of mathematics effectively? Moreover, how can we develop these skills during a brief Post Graduate Certificate of Education (PGCE) course? I suggest that if we increase the range of mental calculation strategies of student teachers, this should have a positive impact on the way they teach children. I conducted a small-scale study with a group of five PGCE students in their last term of training, in order to answer the following questions:

1. What mental calculation strategies do the students possess?

2. Can my intervention enable the students to learn a range of mental strategies and use them effectively?
3. Are the students confident in their own abilities to teach a range of strategies?

The Study: Context and Methods

The students who were focused on for this study included three mature students who had primary aged children of their own who I will refer to as Carol, Donna and Ellie and two who did not (Ann and Belinda). At the beginning of the session the students completed a simple questionnaire to ascertain whether they felt they knew a range of strategies and whether they felt confident teaching mental mathematics. Similar questionnaires were completed at the end of the session to note any changes in confidence and knowledge following my intervention. Fifteen questions were asked in a 'test' situation, covering all four operations (+, - , x, ÷) and each was displayed on an individual PowerPoint slide for a limited time. Results were recorded in writing. During the session a range of calculation strategies were taught, discussed and practised and the whole session was audio taped. This was followed five weeks later by further questionnaires and a shorter teaching session.

Examples of strategies used initially by the students

Question: 483 + 89

Donna immediately knew that she would like to add 90 then adjust her answer by 1 but she didn't like crossing the hundreds boundary. Ellie would not have attempted this mentally, she would have written it down in a vertical format. Belinda, the youngest student, immediately turned this into 482 + 90. She then split the 90 into 20 and 70, having calculated that she needed 20 to add to the 482 to get to the nearest hundred (502) from where it was easy to add on the remaining 70 (572). There was no final adjustment needed as she had deducted one from 483 at the beginning, knowing that if she added one to the 89 to make 90 she needed to deduct one from the 483 to keep the calculation exactly the same. I feel this whole method showed a sophisticated understanding of the number system and a confident approach to manipulating numbers for ease of calculation.

Ann (second youngest) approached this calculation differently by rounding to the nearest 100 and adjusting. She clearly felt that 89 was close enough to 100 to make this strategy work so quickly added 100 to 483 (583) then subtracted 11 by partitioning into 10 (573) and 1 (572). The entire group agreed that this method would be the most efficient.

Question: 58 – 34

The students all used different methods for this calculation. Belinda deducted the 4 (54) then 30 (24). Ellie added on from 34 to 58 (34 + 20 = 54. 54 + 4 = 58. 20 + 4 = 24). Carol subtracted 30 from 50 and 4 from 8 then added the results together (50 – 30 = 20. 8 – 4 = 4. 20 + 4 = 24) although this prompted a discussion on possible misconceptions if, for example, this had been 54 – 38. Belinda again made this calculation more manageable by rounding the 58 up to 60 then subtracting 30 and adjusting (60 – 30 = 30. 30 – 4 = 26. 26 – 2 = 24).

Initial Findings

In all cases the students felt they had increased their knowledge of mental strategies and they believed their confidence in teaching mental mathematics had grown by the end of this session. Some actually achieved less well on the test at the end of the taught session than on the initial one but attributed this to trying to use the new strategies they had just been taught and were yet to become familiar with.

Having started to analyse these results I began to reflect on the students' understanding of mental calculation strategies and the way that I had taught these. Their limited range of strategies before my intervention, combined with their inability to answer all the questions accurately using these 'new' methods, led me to decide that these students would benefit from more practice with the range of methods, combined with more practice at selecting the most appropriate method. I therefore planned a second intervention to extend my research questions. I was also interested to know what effect, if any, the first session had on their teaching during the final four weeks of their placement.

Second Intervention: Methods

The same students attended a shorter teaching session five weeks after the first one. On this occasion the strategy I used involved them completing a calculation themselves then discussing both their own methods and alternative methods which I had offered to them. This was far less didactic than the initial teaching session and I hoped that it would enable the students to develop a deeper knowledge and understanding. They also completed a questionnaire reflecting on both sessions and identifying any impact resulting from the first one. It is important to note that the students were not aware that this second intervention would be taking place so I feel confident that any impact resulting from the first session was genuine.

Findings

The most significant impact appeared to be on the need to learn doubles and halves rather than any other skill, as the students could see the wide range of uses of this from adding near doubles to multiplying and dividing by 5 or 20. Donna had been encouraging her own children to practice mental strategies, and had noticed that she was using doubles far more in her daily life. She had particularly noticed the importance of learning doubles by heart, in order that they can be used within a number of strategies, and this had directly led to her teaching doubles up to double 5 with Foundation Stage 2 (age 4-5), and up to double 20 with Year 1 (age 5-6) children. Her response to my question about the impact of my two sessions on her future teaching was very positive, showing that she understands the benefit of using different strategies even with very young children.

Ellie had also been using doubles and halves on her final placement, as a direct result of the previous session. She had devised a selection of games to play with her Year 3/4 class and reported that they had been very successful. She felt that during the two sessions she had developed her ability to identify children's mistakes in their methods, as she now had a wider repertoire of strategies that she understood.

All of the students felt that the two sessions had an impact on their own learning and their confidence in teaching, and four explicitly recorded the usefulness of the first session as a reason for attending the second. From my own experience I know how hard it is to begin using different strategies after spending many years

using effective, but possibly not efficient, methods. This is supported by the findings of both Goulding et al (2002) and Huntley (2005). In addition, Donna and Carol commented on the balance of pedagogical approaches used in the sessions which would transfer to their classroom situations. This is a useful observation as Shulman claims that 'it is not only knowledge of content but also knowledge of how to teach content that influences teachers' effectiveness' (cited in Hill et al 2005, 377).

Conclusions

This study has led me to believe that just a small amount of input for student teachers can have a large impact on their understanding, knowledge and ability to focus on these key strategies in school. These students all brought a range of mental strategies with them, many of them being used very effectively. However, they all agreed that being aware of a wide range of strategies was a key skill for their own teaching (to understand children's methods) and for children's learning (so that they can select the most effective and efficient strategy). Following the first session three out of the five students chose to include mental maths in their teaching, despite this not being part of their original planning. This indicates to me that once strategies have been taught, time can be found within the maths lesson to rehearse them.

A second conclusion that can be drawn is that there is a direct link between a student's own subject knowledge and their confidence in teaching the topic, as suggested by Huntley (2005) and Goulding et al (2002). This does not necessarily mean that the students are competent at teaching it; a further study would be needed to establish whether there is a link between confidence and competence.

Williams recommends 'a renewed and sharper focus on the use of mental mathematics' (DCSF 2008, p.66) and I believe that there is a key issue that Initial Teacher Education and Continuing Professional Development programmes need to consider in order that this will be done effectively. There needs to be an acknowledgement that qualifying student teachers do not necessarily know the wide variety of strategies which are clearly set out in the Numeracy Framework (DfEE 1999). If my sample is representative of all student teachers, what are the implications for current teachers, particularly those recently trained? I suggest that there is much work still to be done.

References

DCSF. 2008. *Independent Review of Mathematics Teaching in Early Years Settings and Primary Schools.* Nottingham, DCSF

DfEE. 1999. *The National Numeracy Strategy Framework for Teaching Mathematics.* Sudbury, DfEE.

Goulding, M., T Rowland and P Barber. 2000. 'Does It Matter? Primary Teacher Trainees' Subject Knowledge in Mathematics'. *British Educational Research Journal* 28(5): 689-704

Hill, H. C., B Rowan, and D L Ball. 2005 Effects of Teachers' Mathematical Knowledge for Teaching on Student Achievement *American Educational Research Journal* 42(2): 371-406

Huntley, R. 2005 An evaluation of primary trainees' views of the subject knowledge audit process. *Proceedings of the British Society for Research into Learning Mathematics* 25(3): 63-68

O'Sullivan, L., A Harris, M Sangster, J Wild, G Donaldson and G Bottle. 2005. *Reflective Reader: Primary Mathematics.* Exeter, Learning Matters