STUDENT TEACHERS, MENTAL MATHEMATICS AND THE NUMERACY SKILLS TEST

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All primary and secondary Initial Teacher Training (ITT) students, irrespective of their subject and/or age specialism are required to pass the numeracy skills test, which was introduced in May 2000. The test is in two parts: a mental mathematics section and a written section. With this in mind, this paper reports on initial findings from a small support group of 10 year 2 BA (Ed) students who identified themselves as needing support with mental mathematics. In brief, my findings highlight several important factors including the effects of low self- image about mathematics ability and the gap between a student's subject knowledge and understanding.

INTRODUCTION

The Government official policy surrounding the numeracy skills test suggests that this test is both relevant for student teachers and will ensure that teachers entering the profession are numerate. It is against this backdrop that a quartet of mental mathematics support sessions was set up, for students who felt that they would benefit from support in their mental mathematics. I worked initially with 10 students during November 2002. I will only report on one student Carol later on in this paper, due to limitations of space. The aim of the sessions was to help the students identify techniques and strategies for tackling mental mathematics questions through the use of practice questions made available on the Teacher Training Agency (TTA) website followed by an analysis of what the sessions revealed about their knowledge and understanding whilst trying to boost their self confidence. My decision to focus on mental mathematics was influenced by my observations of student teachers in the classroom and their responses during taught sessions at University. With the implementation of The National Numeracy Strategy (NNS) (DfEE 1999) into most state schools, mental mathematics has received more prominence than in the past.

DATA COLLECTION

Several methods of collection were employed. At the first session the students were asked to fill in a brief questionnaire. The issue of adults' lack of confidence in mathematics is well documented. The questionnaire was devised to illicit information concerning how the ten students viewed their own ability in mathematics and how they felt teaching mental calculation strategies to children in school. The students were asked to keep an ongoing diary in which they were asked to record three things: their confidence level, what they felt that they understood and targets that they wanted to set themselves each week. At each session the TTA practice questions were administered under test conditions and the results for each student along with their jottings was collated and analysed. Several students attended a semi- structured interview at the end of the quartet of sessions in which their progress was reviewed and what they felt they needed to work on further. Of the initial group of ten students, four returned to follow up sessions in May 2003.

STUDENT TEACHERS' FEARS AND ANXIETIES ABOUT MATHEMATICS

Fear and anxiety can get in the way of performance. Ball (1988) believes it is important that negative feelings are acknowledged. Such feelings can shape what students' view of the nature of mathematics is. Much has been written about student teachers' fears and insecurities about mathematics (Crook and Briggs 1991, Green and Ollerton 1999), which have persisted from childhood into adulthood. Crook and Briggs (1991) talk about unpacking personal bags containing mathematical knowledge-complete or incomplete.

TYPOLOGIES OF KNOWLEDGE

Grossman, Wilson, and Shulman (1989) believe that subject knowledge has been treated as something that is “...all powerful or exposed as mere humbug...” (p.23). According to Shulman (1986) content knowledge can be separated into three categories: subject matter content knowledge (SMK), pedagogical content knowledge (PCK) and curricular knowledge. In defining content knowledge Shulman asserts that such knowledge is “the amount and organisation of knowledge per se in the mind of the teacher” (Shulman 1986, p. 9). He views PCK as going beyond SMK to “knowledge for teaching” (Ibid. p. 9). Curricular knowledge involves knowledge of the curriculum materials available for teaching a particular subject, an understanding of the breadth of the curriculum, so that one knows what was taught before and what will be taught in the succeeding year in school (Shulman 1986).

The way in which Shulman has presented his ideas lends itself to one compartmentalising the three components of knowledge and overlooking the links and relationships between each. He does identify links but in a limited way. Aubrey (1997) believes that Shulman's work “provided a system with potential for rich new understanding of teachers' subject knowledge” (p. 9) and that the way he subdivided teacher knowledge was to draw attention to those areas of research which needed further exploration. Subsequently Shulman is not without his critics. McNamara (1991) questions whether “it is possible to make a clear distinction between SMK and PCK and from there to then argue that content knowledge has a distinctive contribution to the training of teachers” (p. 119). Mc Namara (1991), citing the research and findings of empirical studies carried out by researchers such as Peterson, Fennema, Carpenter, and Loef, (1989), suggests that both SMK and PCK are changed and influenced by practice. According to Meredith (1995), PCK as presented by Shulman does not allow for other types of pedagogy. Its roots seem to lie with a “particular representation of knowledge” (p. 176).

UNDERSTANDING

> No amount of practice and rote learning will take the place of ...experience; unless practice and rote learning are concerned with the ideas that have become part of a child they will never lead to real understanding. Those who are taught skills...without a foundation of sufficiently wide practical experience will acquire spurious and superficial techniques which may mislead the teacher into supposing there is understanding where in fact none exists (Mathematics Association, 1955, as quoted by Love and Tahta (1991)).

It is difficult to talk about knowledge without making reference to understanding. Does knowledge of, for example how to teach a particular mathematics topic, mean that one understands the concepts connected to that topic? Much has been written about what understanding is and how one comes to understand. One such writer, Sierpinska (1994) has explored what understanding and meaning are and the processes involved. She describes the act of understanding as “an experience that occurs at some point in time and is quickly over” (p. 2). Duffin and Simpson (1994) pick up on this point. The authors believe that “on its own, the ability to do or to reproduce a procedure is not enough to ensure that understanding is present because it may merely imply a good memory” (p. 29). They also believe that the term is used “copiously by people in teaching and learning, but attempts to establish a satisfactory shared meaning for it are less common” (p. 27). Skemp (1995) in a presentation given in 1976 described two types of understanding: relational and instrumental. He described relational understanding as understanding that “corresponds to intelligent learning” (p. 1) and instrumental learning as “habit learning"(Ibid).

Is one form of understanding better than another? There are benefits for each. Some of the benefits of instrumental understanding cited by Skemp include ease of comprehension and the rewards of getting things right. Getting things right means a student will pass the numeracy skills test but does it provide a student with the necessary understanding to teach fractions, decimals and percentages in the classroom? With regard to relational understanding Skemp lists benefits such as ease of adaptation to new tasks and remembering. Similarly Sierpinska (1994) identifies some characteristics of understanding which can be perceived as involving explanation, performance and reasoning. Sierpinska's insight about understanding is not dissimilar to that of Skemp. Maybe the link between understanding and knowledge lies in the depth of knowledge or as Duffin and Simpson (1994) state: “evidence of being able to do is a partial indication of the presence of understanding but by itself it is not enough” (pp. 29-30).

CASE STUDY: CAROL

Carol was able to identify quite clearly those areas of mathematics that she felt that she had no understanding of. She feels confident in teaching mental calculation strategies up to year 2. She stated, when asked how confident she felt teaching mental mathematics to children in school that: “I have no problem researching what I do beforehand and doing the practice often consolidates my own learning too”. Carol has dyslexia and she spoke about not being able to remember what to do due to her memory problems: “I have never been able to remember tables”. She feels that this has hindered her progress in mathematics.

Carol: November 2002

Her test results suggest that arithmetic with an aspect of problem solving causes her the most difficulties. This links well with what she shared with me during her semi-structured interview during which she said, “two bits of information are okay but more then I end up with a row of numbers”. Similarly when a question involves her carrying out more than two steps she is able, at times, to engage with what she has to do but she sometimes fails to carry out the last vital step to obtain the correct answer. What is also apparent is that there are times when she does not know what to do with the information if it is presented to her in two different forms such as a percentage and as a fraction. Her knowledge appears instrumental and compartmentalised.

Carol's shifting position

What is clear from Carol's diary is that each week she was able to identify pieces of knowledge and understanding that she had learnt including: partitioning; creating grids and tables to show information clearly; finding 10% and working from there; and the benefit of knowing the equivalent percentage and fractions. She was also able to set herself targets each week in addition to representing her knowledge of fractions in a different form by way of grids that she put up on her wall-the type of representations that she could use with children. Ball (1988) supports a notion suggested by Ma (1999) that “understanding mathematics in order to teach it means being able to think pedagogically about the subject” (p.43). Carol was beginning to explore the ‘why’ underlying the ‘how’ and this led her to the basic ideas at the heart of mathematics (Ma, 1999). My adaptation of a quote by Brown, Mc Namara, Hanley, and Jones, L. (1999) can sum up Carol's shift (I have italicised my adaptations):

> The transition from *unconfident* mathematics scholar to *confident* mathematics scholar, the complex process of learning to teach *and to believe that you can teach*, develops as a subtle interplay of the parts of the whole. For the aspiring primary teacher one such part is the initial transition from school learner of mathematics to student teacher of mathematics. This transition, if it is to be successful, must, for many involve a considerable degree of 'unlearning' and discarding of mathematical baggage, both in terms of subject misconceptions and attitude problems (p. 301).

CONCLUSION

As a result of my work with the students I want to add another facet to Shulman's notions of PCK and SMK, combining his notion of content knowledge with Skemp's ideas about understanding. I wish to argue that PCK can be subdivided in two ways: knowledge of how to teach with either a relational understanding or an instrumental understanding. Similarly SMK can be subdivided: knowledge of topics with knowledge/understanding of the links between the topics and knowledge of topics but each piece of knowledge is compartmentalised. My research would suggest that Carol and her peers shifted between the four positions described. Furthermore attendance at the support group helped to challenge their own knowledge and understanding (their personal baggage) and how to use mental methods both to pass the numeracy skills test but more importantly to enhance their mathematics teaching in school.

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