Waite, S. and Gatrell, M. (2005), 'Making a patchwork quilt: the role of the National Numeracy Strategy for primary student teachers in mathematics', in D. Hewitt and A. Noyes (Eds), *Proceedings of the sixth British Congress of Mathematics Education* held at the University of Warwick, pp. 176-183. Available from www.bsrlm.org.uk.

MAKING A PATCHWORK QUILT: THE ROLE OF THE NATIONAL NUMERACY STRATEGY FOR PRIMARY STUDENT TEACHERS IN MATHEMATICS

Sue Waite and Marion Gatrell

University of Plymouth

In our longitudinal investigation of the development of primary undergraduate and postgraduate student teachers' mathematical subject content knowledge, understanding and skills, we explored the nature of the role that the National Numeracy Strategy (NNS)(DfEE, 1999) has played in specialist and non-specialist mathematics student teachers' development. This paper considers alternative models of teaching and mathematics and explores how critical reflection combines with external factors such as the NNS to underpin the pedagogic content knowledge and skills which are the principal focus for many student teachers.

INTRODUCTION

Our study is set in the context of the implementation of the National Numeracy Strategy (DfEE, 1999) which signalled a move from the specification of content of curriculum to the delineation of teaching methods (Brown et al, 2000). The implementation of the NNS in conjunction with the Standards for Qualified Teacher Status (DfES, 2002) stimulated renewed debate on the professional development of student teachers. Our research explores the factors that contribute to student teachers' own perception of their development as mathematicians and as teachers.

Mathematics models of teaching and the NNS

Two principal models inform our thinking about the relationship between the nature of teaching implied by the NNS and student teachers' development. First, Kuhs and Ball (1986) identify four types of mathematics teaching:

- learner-focused
- concept-focused with an emphasis on conceptual understanding
- content-focused with an emphasis on performance, and
- classroom-focused.

The first three relate to the three conceptions of mathematics also described by Ernest (1989): the problem solving view, the Platonic view as a given, coherent body of knowledge and the instrumentalist view as a useful but disparate collection of facts and skills. Learner-led investigations appeared to be more frequently employed by student teachers with secure subject knowledge. In Kuhs and Ball's (1986) fourth type, however, the content is determined by other than the teacher and taught

according to a set of prescribed teaching strategies. The latter two types strike a chord with the NNS and the Standard Attainment Tests (SATs); the content of the Strategy is determined centrally and teachers are strongly recommended to use its three part lesson structure and particular teaching styles during their lessons. Although it is intended primarily to raise standards of numeracy, the NNS may also support a tendency of some student teachers to adopt an instrumentalist approach to teaching mathematics, in which coaching the children to reach a certain standard in tests is paramount.

Second, Wood (2000) suggests a hierarchy of conceptions about teaching:

- Conception A, where the teacher is seen as an agent of teaching and the focus is on imparting knowledge,
- Conception B, which focuses on the act of teaching or preparing pupils to use knowledge
- Conception C, which concentrates on the object of teaching or the ability of teachers to change the way pupils understand their subjects through making sure the teaching is responsive to pupils' needs. As such, it is learner-led, featuring flexibility and a variety of teaching strategies, which are characteristic of effective teaching (DfEE, 2000).

The NNS appears to sit within Conception B; it promotes the view that a certain set of teaching strategies together with sequences of pieces of knowledge are regarded as the most effective means of improving standards. Conception B also relates strongly to Kuhs and Ball's (1986) third and fourth types of teaching. There is tension between being responsive to learner needs and a perception of the NNS as a statutory requirement in some schools and student teachers' eyes.

If the NNS is perceived to offer a rigid framework for curriculum delivery, how are primary student teachers to move beyond an instrumentalist view of teaching towards Wood's Conception C, which values understanding, is flexible and reactive to children's needs? Edwards (1997) found student teachers presented themselves from the outset as competent, subjugating their own role as learners. Despite contrary expectations of mentoring and school partnership arrangements, many schools' emphasis on 'getting the job done' may marginalise the students' attempt to cohere the theoretical and practical elements of their course. Student teachers may be obliged to adopt the schools' norms (Drever and Cope, 1999), and this may correspondingly cramp their critical reflection (Fisher, 2003) on observed practice. Schools themselves may feel obliged to adopt norms implicit in initiatives such as the NNS without critical reflection to meet the demands of OFSTED inspections (OFSTED, 2003).

In this paper we argue that the NNS and associated published schemes may therefore provide scaffolding (an external frame) to support or straightjacket developing student teachers' internalisation of pedagogical principles. However, we suggest that critical reflection offers a means to greater relational understanding of the disparate

pieces of pedagogical content knowledge which the NNS represents.

RESEARCH DESIGN

We chose a longitudinal research design over 5 years, tracking student teachers drawn from each year of a 4-year BEd (Hon) degree programme of study at the University of Plymouth through their time at university and beyond. Male, female and upper and lower primary age phases were represented with 4 or 5 student teachers per year, half taking mathematics as their subject specialism. Student teachers volunteered to take part following an initial approach by their tutor. In some cases, it was not possible to meet the student teachers each year. While experienced mathematics tutors (Brown et al., 1999) may be able to identify mathematical issues more acutely, problems with power relationships between tutor and student teacher could bias student teachers' responses to impress their tutors. An open relationship between research assistant and respondent developed over time and thereby reduced pressure to perform and conform. Each student teacher was interviewed once or twice a year. We sought to ground the student teachers' comments in experience rather than their cognitive perception by asking about feelings and actions (Marton, 1994). We asked how comfortable and confident the student teacher felt with mathematics and for specific examples of experiences which had had a major impact on their learning using a phenomenographic approach with multiple interviews. Student teachers reflected on their strengths and weaknesses and their view of mathematics. We checked our interpretation of their comments with the student teachers. Subsequent interviews broadly followed the same pattern as the initial interview. Occasionally we reminded the student teachers what had been said at earlier interviews. However we wanted to tap into an immediate affective response, the intuitive, as this might influence actual practice in the classroom, and help to explain some of the differences sometimes observed between rhetoric and reality (Ensor 2001). We became aware that the research itself represented a structure for student teachers to support their developing ability to reflect.

Some bias may exist because the researchers came from the same institution and a subset of 'keen' students may have been created for the study as those lacking interest or struggling may not have volunteered to take part. Our results therefore only suggest possible relationships which require further research.

DATA ANALYSIS

All interviews were transcribed verbatim and repeatedly read to carry out a content analysis of themes. As the study progressed and more data was collected, provisional hypotheses about key influences on mathematics student teachers were developed and tested against the data. The transcripts were finally coded according to a developed framework and entered into N5, a qualitative software program. Coding electronically meant that we could explore different theories about relationships between the complex factors more easily because the text could be assigned to several pertinent nodes and nodes could be combined and compared more readily.

OUR FINDINGS

For the purpose of this paper, we selected the interview transcripts (31) for student teachers (n= 10) for whom we had data over a period of 3 years or more. These were mainly specialists (n=7) and we do not therefore focus separately on specialist and non-specialist groups in this paper. However, it is clear from examples given that non-specialists may rely on external structures if they lack conceptual understanding of mathematics. Furthermore, although student teachers progress at different rates, a trend towards Woods (2000) Conception C and the first two types described by Kuhs and Ball (1986) seems to be common to all. In the next section we highlight how critical reflection, the evaluation of beliefs and actions of self and others, and the influence of the NNS interacted.

Developing views of the NNS and teaching

Some of the student teachers, especially in the early years of their initial teacher education, found that the NNS provided them with a firm foundation for planning and preparing their lessons; this gave them both security and confidence when planning their lessons and then standing before the class:

> Shelley: There's so much organising, and you know, with the Numeracy Strategy now it's all there for you, what to teach, when to teach. […]
>
> It more or less tells you what to do. (Year 1 specialist 1999)

Student teachers may initially feel uncertain about *how* to teach and may rely on the NNS to fill gaps in their own pedagogical content subject knowledge. In her second year, Ellen discovered support in the NNS, which she calls her 'bible', perhaps signalling a 'blind faith' in its contents (Year 2 non-specialist 2002).

White (2000), commenting on the beliefs of pre-service teachers, found they ranged along a continuum from belief that knowledge is certain and given to a belief that knowledge is uncertain and can only be deduced from evidence. We found the student teachers seemed to begin with a search for definitive answers to effective strategies, in effect,' what works'; but that, as confidence grew, more uncertainty could be tolerated and acknowledged, and flexibility and adaptability was valued more (Waite & Gatrell 2004).

To some extent this 'what works' attitude has been the main thrust of the government's claims for the NNS as a source of tested and successful methods (DfEE, 1999, p.2). We found that less confident student teachers relied more heavily on the structure that the NNS provides, perhaps lacking a personal understanding of the conceptual links between areas of mathematics (OFSTED, 1999, p. 9). One specialist student teacher reflects on a lack of relational understanding of mathematics on his school experience:

> Harry: I wonder whether they had had the Numeracy Strategy and treated it as a bit of a bible …once we had got that with multiplication we went on to division and they didn't know what division was…and it amazed me that they hadn't

got any of those relationships at all. (Year 4 specialist 2003)

Harry's comments echo Ellen's, in that the NNS seems to be revered and unquestioned in some schools as well as by some student teachers. In this sense, the NNS appears to be constraining critical reflection on pedagogy.

Polly: …schools are taking the National Numeracy Strategy as being statutory and following it like a long term plan rather than as a framework of ideas or suggestions as to where the children should be. (Year 4 specialist 2002)

Critical reflection may enable more links to be made between aspects of pedagogy (Fisher 2003). This relational understanding also seems to be linked with a Platonic aspect, in that student teachers' knowledge becomes related and coherent rather than a ragbag of rules. A student teacher reflected on the lack of relational structure in the NNS:

Shelley: And it doesn't talk about making links and connections, does it, from what I can remember? (Year 3 specialists 2001)

In contrast, an instrumental view of necessary subject knowledge is often associated with a transmission model of teaching as it assumes the ragbag can be taught in discrete pieces, and that each 'piece' can be studied by the teacher in isolation. This echoes Platonic fixed and immutable rules.

Helen: You know I've been fretting over this for days, getting up early and looking through the books […] it's like I'm just staying one step ahead of the children and anticipating what they might ask. (Year 1 non-specialist 2001)

It could therefore be said that the NNS has simply sewn the rags (dislocated teaching objectives) into a quilt (medium term plan) for teachers, creating a structure which may support those trying to teach mathematics when their own understanding of mathematics is weak and cannot personally provide the links between different areas.

As the research occurred as the NNS was being implemented, student teachers were in an unusually privileged position. Student teachers could bring their knowledge of the NNS as a 'gift' (Edwards, 1997) to schools.

Brenda: I think we're very fortunate having been here at the time of the Numeracy[...] we're more prepared than some of the teachers are. (Y3 non-specialist 2000)

Nevertheless, uncritical adoption of the NNS was not accepted by all student teachers. Some were wary that the NNS did not necessarily allow for the huge variation in attainment they met in classes (Brown et al, 1998).

Polly: But it depends on the ability of the children, if they are able at that stage they should be experiencing Venn diagrams. (Year 4 specialist 2002)

In the early stages of their programme of study, student teachers reflected that their conception of mathematics teaching tended to be either Conception A - agent of teaching, which may have been more compatible with NNS discrete teaching of separate areas:

Ellen: I think I began with a more transmission model. (Year 3 non-specialist 2003)

Or Conception B - act of teaching, featuring a content-focused model of teaching and tending to adhere rigidly to the lesson they had prepared, which again is supported by the NNS structured plan for teaching:

Shelley: I'd got my lesson plan fairly close by […] so it's there if you know I really needed it. […] I always have it with me, just in case.(Year 2 specialist 1999)

As they became increasingly experienced, there was movement towards Conception C - object of teaching; with a greater emphasis on understanding and a learner-focused model of teaching which included greater pupil-responsivity and flexibility (Wood, 2000; Kuhs and Ball, 1986):

Polly: it was 'today we are doing adding up, tomorrow we are doing taking away, the next day we are doing adding up again', so very separate chunks. So, in that respect, I think children don't necessarily get the time to do it in enough depth. (Year 4 specialist 2002)

Once the student teachers were more self-confident, they could begin to use the Strategy as a scaffold not a straightjacket by making critically informed decisions about which NNS ideas to use and what children need to understand.

In this way, it served to support some student teachers' professional development by scaffolding their pedagogical content knowledge (Wood et al., 1976).

Harry: So although it's got some really good stuff in there, I wouldn't like to just […] say ah day three, ah that's right what am I teaching today and just sit there and follow it religiously. I find maths too interesting and too much fun to just do it like that. (Year 2 specialist 2000)

Harry's comments illustrate how content subject knowledge, reinforced with increasing pedagogical subject knowledge and skills, can move beyond the structure and transform mathematics teaching with affective factors such as enjoyment. Although some student teachers continued to endorse an imposed structure.

Brenda: It seems so right, the right way to be teaching it and I like the way it is laid out. (Year 4 non-specialist 2001)

Most of the student teachers in this study professed a social constructivist view of children's learning related to their reflection on how they personally achieved understanding, for example through group support (Waite & Gatrell, 2004). This underlying belief may have influenced a tendency to move closer to a learner focused view of mathematics teaching with an increasing emphasis on knowing where the children are in their learning and being responsive to that.

Wendy: …looking at the children's work more critically and saying well why have they done that mistake, you find out where problems are. (Year 3 specialist 2000)

Sensitivity to children's needs and critical reflection of those in relation to the 'huge web of things that are interrelated' (Year 4 specialist 2003), we suggest, has the potential to transform the patchwork quilt of the NNS into a more cohesive woven fabric of pedagogy.

CONCLUSION

Alexander (2004, p21) states that, despite notable changes in teaching methods and patterns of classroom organisation resulting from the implementation of the NNS, practice below the structural surface has changed rather less. In his view, an instrumental approach to 'what works" appears to be the ultimate criterion for judging whether a practice is educationally sound. The NNS seems to suggest a transmission model of mathematics teaching as areas of mathematics are presented via discrete teaching objectives. This may not only mask the relational aspects of mathematics whereby meaningful links for learners are made between different concepts, skills and knowledge but may also bypass sensitivity to children's learning needs. A further tension arises when the NNS is used in an inflexible way by student teachers for whom replication of their own experience remains a powerful influence.

Our findings suggest that the NNS' impact for student teachers and their practicum schools is not without ambivalence. The NNS demands adequate content and pedagogical subject knowledge from teachers for its effective implementation; without it, it becomes merely a checklist of separated mathematical concepts, skills and knowledge. However, subject knowledge alone is insufficient. We argue that only critical reflection of the NNS and practice can provide the thread that connects its various materials so that children may enjoy relational and cohesive mathematical experiences. Critical reflective practice therefore remains a powerful strand in the development of responsive and learning teachers (Waite & Gatrell, 2004).

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