Do students' beliefs relating to the teaching of primary mathematics match their practices in school?

Caroline Rickard

Initial Teacher Education, University of Chichester, UK

This paper reports research findings from the second year of a small-scale, longitudinal case study undertaken with undergraduate students at the University of Chichester. This four year project seeks to explore the impact of the beliefs of students in Initial Teacher Education (ITE) upon their teaching of primary mathematics, noting placement constraints. Data collection involved observations and interviews, and took place in the latter half of a six week block of school experience.

Keywords*:* Mathematics; Beliefs; Primary; Teacher Education; School Experience

Aims and introduction

Working in ITE since 2001, I seek to engage students in mathematics in a way which reflects my beliefs about how mathematics should be taught to primary age children, noting that as teachers we "convey messages about the nature of mathematics by the way we teach it" (Nickson, 2004: 43). Interviewing ten first year undergraduates after a six week introductory mathematics module established, unsurprisingly, that their views about how primary mathematics should be taught broadly reflected my own (Rickard, 2008). A clear question remained however:

- Would clearly articulated beliefs relating to the teaching of primary mathematics match the students' practices on school experience?

The purpose of this next phase was thus to observe some of the students' mathematics teaching in order to investigate the transferability of their beliefs into the school context; in particular whether their beliefs were resilient enough to withstand the demands made upon student teachers, and whether a particular school placement might constrain or shape the student teacher's views. Various sources (see for example Brown and Borko, 1992) caution that classroom pressures may mitigate against application of perceived 'best practice' however "early and continued reflection about mathematics beliefs and practices, beginning in teacher preparation, may be the key to improving the quality of mathematics instruction and minimizing inconsistency between beliefs and practice" (Raymond, 1997: 574). Williams supports this view suggesting that involving students in "articulating and discussing beliefs and practices associated with mathematics" (2001: 447) is likely to result in more effective practices.

Methodology

Data was gathered through observation and interview in the spring of 2009 with a triangulation of methods chosen because, as Elton-Chalcraft *et al* (2008: 79) point out, "observations can be useful for overcoming the difference that can exist between what people say and what they do in practice". Holding interviews directly after the observations also gave an opportunity to discuss any additional beliefs, noting that not all beliefs were necessarily going to be explicitly incorporated in any single observation. Three opening questions were identified in advance:

1. What would you have done differently in that lesson given the chance? (Incorporating self-evaluation and leading to exploration of whether anything prevented students from doing what they wanted, asking them for example to reflect on pedagogical beliefs they felt they had to put 'on hold' during the placement.)
2. Since the initial interview asking you about your beliefs as to how primary mathematics should be taught, are you conscious of any changes to those beliefs? (Including describing the new beliefs and what students felt had caused them to alter.)
3. Are there any other examples you want to give of mathematics lessons you've planned and taught which you feel would help to exemplify your beliefs? (An opportunity to explore beliefs and practices over the slightly longer term.)

Four of the original research group were observed; students who knew me and were willing to participate in the interviews in their first year and then available in year 2, and in this respect a climate of trust (Hopkins, 2008) was easily established. One participant, Jenny, was taking a secondary rather than a primary placement (names have been changed to preserve the anonymity of the students). Observations were undertaken on a non-participant basis.

Figure 1 shows the responses relating to the most commonly expressed beliefs in the original interviews in the first year of the research (n=10) and these features were developed into a simple observation schedule for use in the second phase.

ETHOS... there should be a positive atmosphere in the mathematics classroom; the word 'fun' was mentioned a lot, and a desire to avoid mathematics being perceived as boring.	70%
DOING... an emphasis on practical mathematics lessons using a variety of resources, with the phrase 'hands-on' used several times.	70%
CONTEXT... referred to in various ways including mathematics linked to themes, cross-curricular opportunities and real world mathematics.	60%
DISCUSSION... opportunities for children to talk about their mathematics, often linked to implications for working in groups.	50%

Figure 1.

Interval sampling helped to focus my attention on how frequently (if at all) I was seeing the sorts of practices that reflected my students' original beliefs. Having pre-determined categories for observation may have helped to address issues of reliability to some extent, but personal expectations may have been a potential source of bias: "Put simply, you are more likely to see the things you expect to see, and hear the things you want to hear" (O'Leary, 2004: 176). The schedule was accompanied by a page for notes about the context of the observation, such as the number and age of the children, organisation of the classroom, and of course detail of the mathematical focus. I also recorded information about the setting and/ or ability grouping of the children.

As a result of piloting the observation schedule, systematic recording in the 'ethos' column was abandoned, value judgements being too subjective. It was however pleasing to note that students praised children regularly, congratulating them on their effort and achievement.

Findings

Four observations took place in May of 2009 in different schools in West Sussex and the background information is summarised in figure 2.

Janey	Y1 (n=27)	Mixed ability class organised into three ability groups.	Counting on, including crossing a tens boundary.
Amelia	Y1 (n=27)	Lower ability set.	Collecting data from peers including tallying.
Jill	Y3 (n=31)	Lower ability set organised into ability groups.	Multiplication relating to multiples of certain creepy crawlies (e.g. spiders) with certain numbers of legs.
Jenny	Y10 (n=14)	Average ability set n an all boys school.	Revision of geometrical constructions.

Figure 2.

In the interviews which took place after the observations, three of the four students reported that they would have liked to have done things differently given more freedom. Interestingly the fourth student, Amelia, would herself have made minor changes but none of these related to a lack of freedom, or in fact to the improvements her mentor felt were required. Whereas the others spoke a lot about the children's learning in reflection on their lessons, Amelia's focus was associated more closely with things *she* would do differently, for example not talking over the children (waiting for quiet) and making greater use of a puppet.

Several themes emerged from the analysis of the data; these will be reported under the same broad headings as those taken from the original research, ignoring 'Ethos' however as mentioned above.

Doing

This category encompassed the idea of practical activity and the use of resources, and issues associated with equipment use came to light even before the visits took place! In emails prior to my visit Jill wrote about being asked to teach without using resources, something which the class teacher had suggested would help the Y3 children to better develop their mental skills. Jill felt she was in an awkward position as she privately disagreed, feeling that a number of the children were struggling and failing to make progress as a result. She was however 'allowed' to use resources for her observation, which suggests that this was a 'special' lesson for my visit, something which Bryman refers to as 'reactive effects' (2008: 266). O'Leary (2004) warns that any person who knows they are being observed is likely to alter their resulting behaviour and my students' awareness of the research focus was unavoidable having already asked them to articulate their beliefs about the teaching of primary mathematics in year 1. As the schools were oblivious to my research focus however, I hadn't, perhaps naively, anticipated any alteration to school practices on account of my visit. Whilst Jill felt that this lesson had been more successful as a result of the use of resources, she went further to say that she would still have done things differently had the class teacher been in agreement, for example providing photocopies of the minibeasts on the children's tables so that to start with they could count the numbers of legs if they needed to. Interestingly, she was the only one of the four research participants who had not explicitly mentioned practical activity through use of resources in her original interview, and yet it is clearly something she now feels strongly about. Jill's lesson also provided an explicit attempt to have children 'doing' as she had given out mini whiteboards which were used for 17% of the lesson.

Janey felt that I would have seen a greater level of interaction in other lessons, for example when she made a broom handle into a physical/ visual numberline and through her regular use of stories and songs. She reaffirmed her belief that mathematics should be taught using a creative approach; she said that she would have liked to take the children outside or

into the hall for more of their mathematics lessons, but was concerned that she would find it difficult to control her "*bubbly*" class. In this lesson examples of practical activity were fairly minimal such as inviting children to hold items or stick things up on the board.

Typical to any secondary placement, Jenny was working across different classes and with different members of staff, and she cited a particular member of staff, an ex-student of Chichester, whose classroom and teaching style she felt were noticeably different to the other practitioners, incorporating lots of engaging resources. In Jenny's original interview she had talked about the benefits of practical activity using resources, and whilst this lesson necessarily met this condition (geometrical constructions using a ruler and pair of compasses) she would like to have made greater use of resources in her other lessons. General expectations of silent working were also mentioned by Jenny in relation to constraints on doing more "*interesting things*".

The opportunity for children to engage in practical activity was most extensive in the lesson taught by Amelia as the children were circulating the room to gather data. In many ways, however, the fact that all four lessons were on different themes makes it difficult to compare them effectively.

Context

The value of context related to the teaching of mathematics was mentioned by Janey, Jill and Amelia in the original interviews and all three lessons included some reference to a context. The strongest link was in Amelia's lesson but as mentioned above, comparison is affected by differences in focus; this was a data handling lesson and data has to be about something! Jill's lesson made effective use of bugs (the focus of about 35% of the lesson) to exemplify multiplicative structure (numbers of legs) and Janey told a short story about a character who was scared of crossing the tens boundary, but links made to this focus were only briefly maintained. She did however speak articulately about making greater use of links to real life in other lessons.

Jill stated that she had become far more conscious of the importance of context as a result of this placement; she reported that the focus had been predominantly upon pure calculation, and that the children had then struggled with some complicated word problems which she had been given to use with them.

Jenny didn't mention context in her original interview and the observed lesson wasn't linked to any aspect of real-life or similar.

Discussion

Talk opportunities were mentioned as a feature of best practice by Jenny and Amelia in the original interviews. Classroom talk in all four observations was predominantly interactions between the teacher and the children, and only Amelia explicitly directed children to talk to their peers about the mathematics, although Jenny did invite pupils to the board to explain their work. Directed discussion occurred in 24% of Amelia's lesson; 4 minutes being allocated to the discussion of something specific with a partner, and 9 minutes of collecting data from peers, an activity which necessitated discussion. In reflecting on her lesson Jill mentioned that she thought her teaching was dominated by teacher talk, and this was indeed borne out in practice. The emphasis in all four lessons was upon the teacher asking and the children answering questions, and the giving of instructions for work, behaviour reminders etc. There was also self-initiated discussion between pupils in all four lessons; many of Jill's Y3 children discussed the mathematics between themselves whilst they were working, and this focus on mathematical talk continued until nearly the end of the lesson. With both Y1 classes however, the talk more often seemed to relate to off-task topics of discussion.

In addition to the three themes explored above, two new themes also emerged: issues associated with lesson structure; and opportunities for children to think for themselves.

Lesson structure

Volunteering reflections on lesson structure both Janey and Jill stated clearly that they would have liked a better link between their mental and oral starters and the rest of their lessons, but were constrained by school planning. Jill stated that hers was "*nonsense in relation to lesson*" and she could suggest alternatives that would have better supported the children in preparation for the lesson ahead.

Lesson structure can also be linked to notions of pace; in another email communication from Jill, also prior to the visit, she expressed considerable frustration. She was concerned that the pace of the teaching was leaving children behind, writing "*I have a feeling that the children are sometimes lost with the concepts and pace*". In her follow-up interview Jill returned to the lesson structure theme saying that she felt logical steps were sometimes omitted to the detriment of the children's understanding.

Thinking

Valuing thinking was clearly a concern shared by both Jenny and Jill; the idea that children should be given ample opportunities and encouragement to think for themselves in mathematics lessons. When comparing her primary and secondary experiences Jenny stated that she really wished "*the boys to think for themselves*" and to be more independent and Jill made a similar point about her lowest ability group in the set. As these children never worked alone she felt they were not getting "*a chance to think for themselves and play around with numbers*". Jenny stated that whilst last year the "*kids were willing to try anything*", this year the "*children are out of the habit*".

Conclusion and future research

Returning to the original themes, first identified in 2008, it's particularly interesting to note that the notion of 'fun' in relation to mathematics lessons was not mentioned in the same explicit way in this, the second year of the research. One possibility however is that one doesn't necessarily think to mention everything, however important, in the course of a single interview. This may particularly be the case with fairly fundamental and deeply ingrained beliefs. Jill failed to mention the use of resources in her initial interview and yet having limited access to them in this year's placement was quite an issue for her, suggesting that their use may well have been an integral part of her original belief system. Linked to general use of resources is a question over the effectiveness of their use: Jill for example chose to refer to minibeasts, an excellent way of exemplifying multiplicative structures.

With three of the four participants articulating very clearly what they would have wanted to do differently, given the chance, it is possible to conclude that they felt somewhat constrained by their particular school placement. This is good news as it suggests that they will be able to think for themselves and hopefully make some healthy decisions about the way in which they teach primary mathematics in the future. One concern however is the effect of a school experience which is at odds with your own belief system with both Jill and Jenny speaking of doubts; Jill in relation to her own ability to teach, and Jenny the desire to pursue a career in teaching.

Reflective awareness of one's own practice allows us to move forwards; Jill was clearly aware that she was dominating classroom talk and is therefore in a position to try to address this. In fact, a whole new project on how we encourage student teachers to afford the children lots of talk-time in the mathematics classroom would be a very suitable line of

enquiry! This could be linked to Jill and Jenny's opinion that the children they were working with this year were not being offered nearly enough opportunities to think for themselves.

The intention is now to continue to 'follow' this small group of students into their third and final year (when they will be placed in different schools), and where possible into their first year of teaching, noting the issues associated with comparing lessons involving different branches of mathematics and classes of children of different ages. Clearly the most useful focus in the long term relates to how we might support students and newly qualified teachers in remaining consciously aware of their own beliefs, continuing to reflect on their own and others' approaches to the teaching of mathematics, and where necessary to strive for change for the better.

Acknowledgements

Grateful thanks are owed to the small band of participants who have so willingly allowed me to invade their classrooms.

References

Brown, C.A. and Borko, H. (1992) Becoming a Mathematics Teacher, in Grouws, D. A. (Editor) *Handbook of Research on Mathematics Teaching and Learning,* Oxford: Macmillan Publishing Company

Bryman, A. (2008) *Social Research Methods* (3rd Edition) Oxford: University Press

Elton-Chalcraft, S., Hansen, A. and Twiselton, S. (Editors) (2008) *Doing Classroom Research: A Step-by-Step Guide for Student Teachers,* Maidenhead: McGraw Hill Open University Press

Hopkins, D. (2008) *A Teacher's Guide to Classroom Research*, Maidenhead: McGraw Hill Open University Press

Nickson, M. (2004) *Teaching and Learning Mathematics: A Guide to Recent Research and its Applications* (2nd Edition) London: Continuum

O'Leary, Z. (2004) *The Essential Guide to Doing Research,* London: Sage Publications

Raymond, A.M. (Nov 1997) Inconsistency between a Beginning Elementary School Teacher's Mathematics Beliefs and Teaching Practice, *Journal for Research in Mathematics Education,* Vol.28, No. 5, pp. 550-576

Rickard, C. (2008 unpublished) *Developing Beliefs about the Teaching of Primary Mathematics*, University of Chichester

Williams, H. (2001) Preparation of Primary and Secondary Mathematics Teachers, in Holton, D. (Editor) *The Teaching and Leaning of Mathematics at University Level: an ICMI Study*, London: Kluwer Academic Publishers