Forging links and breaking chains in primary teacher education: negotiating powerful ideas

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Abstract

Prospective primary school teachers enter their mathematics education subject sequences in their teacher education programs with a number of chains fettering them to the past. These constraints are analysed and their implications considered. Suggestions for the formation of more flexible links are proposed. Awareness of what students and teacher educators bring to their teacher education courses allows for negotiation of powerful ideas.

Introduction

Prospective primary school teachers enter teacher education programs with distinct notions of what the course should offer them. Teacher educators also have certain expectations for their students. The first year of the program is one in which ideas are gathered, negotiated and used as starting points for the teaching and learning of powerful concepts. Teacher educators in mathematics have the responsibilities of helping prospective primary school teachers to forge links: within areas of mathematics itself; between mathematics and other subjects; and between mathematics and everyday life. However, this paper suggests that before any links can be formed, it is necessary to break some chains.

Ball (1989, 1988) suggests that prospective teachers come to their teacher education programs with clear ideas of what mathematics is and how mathematics should be taught. The picture is made even clearer by the findings of Wilcox, Lanier, Schram and Lappan (1992) who describe preservice teachers' views of mathematics. They believe that prospective teachers often see mathematics as a fixed and sequential body of knowledge that is most effectively learnt by rote, algorithmic and repetitive procedures. Mayers (1994) suggests that student teachers either see mathematics as a body of absolute truths which exist independently of the learner, or as a toolkit of rules, formulas and procedures that are used to gain some end. In either case, the work of primary school teachers in mathematics is seen to differ from their work in other subject areas; mathematics is transmitted rather than constructed. Teaching takes place in a traditional setting of exposition followed by silence in which students engage with textbooks and set exercises. There is little of the more robust interaction which occurs in other curriculum areas.

As a teacher educator in the field of mathematics, it became obvious to me that, in order to encourage change in the way mathematics is taught in the primary school, I needed to be aware of the beliefs of students in the teacher education program in which I am involved. Some of these beliefs act as chains which make difficult the movement towards reform of school mathematics teaching. Knowing the nature of the chains also helps in the formation of new and positive links, an aim of the mathematics education course under discussion. The linkages proposed here are of a more flexible and less deterministic kind than the burdensome chains described. The chains are encumbrances which halt the students' progress and make change extremely difficult.

In this paper, a study concerning the beliefs and conceptions of first year students, regarding the teaching and learning of mathematics, is discussed, as it gives information as to what chains might be tethering the students in their tertiary studies in teacher education. Some alternative links that might be forged once these chains are broken, will be proposed and a possible plan of action suggested.

Methodology of the Study

The study was conducted in four phases. The participants were fifty students, forming two groups from the first year intake into the Bachelor of Teaching primary teacher education program at a university in metropolitan Sydney. In the first phase, students from these groups were asked to pose a series of questions dealing with the dilemmas and issues that existed for them concerning the teaching and learning of mathematics. They then formed pairs with each student acting in turn as interviewer and interviewee. The data was taped and analysed by myself, with the students' permission. I found the questions to be as rich in information as the answers, as the questions indicated what students believed to be of importance in examining issues in mathematics education (Schuck, 1993). Some examples of the questions are given later in the paper.

Out of the collected data emerged the next phase of the study and this was the answering of an open-ended questionnaire by all participating students. The questions developed out of my analysis of the data from phase one, and so were well grounded (Schuck, 1994).

In phase three, eight students from the group were selected to participate in in-depth interviews with me, and a schedule of questions, regarding their beliefs about mathematics and their experiences in the first year mathematic subjects in the teacher education program, were posed. The questions for the interviews were developed from my desire to probe further ideas that had either arisen in the earlier phases, or that I felt would help me to understand better the students' passage through the mathematics education subjects that year. The eight students chosen were selected so as to provide a balance of mature age students and recent school leavers, and also so that there was a mix of students in terms of their demonstrated ability to reflect on their learning and on their practice.

Finally, phase four comprised interviews with the four lecturers involved in the offering of the mathematics education subjects. I wished to ascertain their reactions to students' professed needs and desires regarding the mathematics education curriculum and also to understand fully their rationale in offering the subject sequence. As I was one of the lecturers involved, it was of interest to me to see if my underlying beliefs about the subjects were similar to those of the other lecturers involved, and whether we were agreed on the rationale for all aspects of the sequence. My belief was (and still is) that mathematics is a socio-cultural phenomenon and is learnt by active construction and negotiation within a community.

Results

The data from the four phases is in the process of being analysed. It is clear from the data that both students and lecturers are bound by a number of chains with respect to their perspectives of mathematics.

Some of the questions that the students asked each other in the first phase gave an indication of the mindsets that were chaining them:

Are you a maths person or a words person?

Do you think that maths should enjoy the same importance as English at school?

How, as teachers, can we make maths more interesting for children?

As a teacher how would you try to combat a bad attitude towards your mathematical teaching?

Perhaps the strongest chain binding the students is the chain of past experience in mathematics. Students perceive mathematics as being boring, tedious and difficult. They speak of their past experiences without enthusiasm, but are quite accepting of the fact that this is how mathematics has to be. Their perception is that mathematics is the learning of rules and formulas and the execution of a profusion of decontextualised exercises. These exercises provide, to their eyes, the unpleasant but necessary drill and practice that leads to success in mathematics. Breaking this chain, formed by over seven years of experience, is a priority if students are going to be able to form the links that show mathematics as an interesting and relevant subject.

Consider the following quote from a first year student, Aaron (all names have been changed to maintain confidentiality):

One year I had a teacher who, all he did, was sit there [making us do the work] parrot fashion, ...and that was boring but looking back on it I tend to think that that actually helped, ... because it was only times table, it wasn't anything like you were doing sums or anything, just the multiplication table and it was repetitive and it was pretty boring but I don't suppose I thought of it as boring at the time because everyone was doing it.

Those students who had been successful at the very procedural and textbook oriented ways of doing mathematics were quite satisfied that this would be an appropriate way to teach mathematics: 'I like rote work because it worked for me and I would be quite happy to use that, but I would temper it with other stuff. ... I've always been happy doing sums.' (Mandy, first year student).

Another chain binding the students is their attitude to mathematics . Most of the students participating in the study felt negative about mathematics. This chain creates a particular mindset on entering the mathematics education classroom at university; students are anxious and will revert to this attitude at the first sign of any challenge or change in the mathematics they encounter.

In school my attitude towards maths was very negative and I feel it was basically because of the teaching methods of that particular time; teachers seemed to kill the interest in the subject and made it very hard to understand and it was a subject that we as children felt was difficult. It wasn't a subject for the ordinary student, it was for somebody that was really good... or had a higher intellect, that would do well in the subject. Students with an average intellect, most of us considered ourselves average intellect, weren't really able to grasp the subject. (Debra, a first year student, in a phase 1 interview)

Enmeshed in students' attitudes is another significant chain that shackles the students: their limited subject matter knowledge. Because of their belief that mathematics is purely the learning of algorithms, students feel their current knowledge of primary school algorithms is sufficient and that they do not need to learn the conceptual underpinnings of these algorithms. At the same time, they find the grasping of such concepts quite difficult and are consequently more likely to avoid them and repeat the cycle of teaching procedures by drill from a textbook as this is the scenario with which they are familiar.

The following quote is from Aaron, at the end of the first year of the course. He was discussing his experiences in two mathematics education subjects; the first an orientation to the approaches to mathematics teaching in primary schools and the second a subject in which more explicit mathematics was done in order to raise students' level of subject matter knowledge. The first subject had students carrying out activities that would allow them to see how various topics in primary school mathematics could be taught; the second introduced topics from number theory that were aimed at both increasing students' conceptual understanding of primary school mathematics and mathematics linked to it, and at introducing methods of problem solving and negotiation with the community:

> *..I found the orientation course in first semester excellent, I thought that was the best thing, ...and then [in the second subject] I just didn't find anything in maths ed [in the second semester] really ... I found just about everything really irrelevant... A lot of us had trouble understanding it and I thought if we don't understand it how are these kids going to understand it.*

The last chain which I see tethering the students is that of their educational orientation, or reason for studying in the teacher education program (Gibbs, Morgan and Taylor, 1984). All content covered in the course is assessed by the students for its value in the classroom: Holt-Reynolds (1991) shows how students project themselves into their vision of their future "Self-as-Teacher" in order to gauge the usefulness and validity of any new learning. As discussed above, their "self-as-teacher" role is highly limited by the chains of previous experience and so the circle continues: if "self-as-teacher" has a role in teaching mathematics that is different from that portrayed in the teacher education course, the new role is rejected in favour of the familiar. This can be seen in Aaron's quote above, where he rejected the mathematics experienced in the mathematics education subject, because it seemed irrelevant to his teaching. He continued:

> *I thought most of it [the maths done in this maths subject] would have been things you use as extension activities so I didn't think it was very practical. So... nothing clicked and we thought 'oh what the hell, none of us are going to teach this'.*

Finally, a chain binding the lecturers is that of their underlying philosophy of mathematics. If the lecturers do not have a common view of mathematics, their execution of the subject is going to differ. One view of mathematics held by teacher educators responsible the first year subjects under discussion is that of a socio-cultural view as described earlier. Another view is one that could be described as a formalist philosophy: consider the following quote by one of the teacher educators involved in the execution of the subjects:

> *How would I describe maths? It's a multiplicity of little games that result from sets of rules, so within a particular environment, taking some set of characters like numbers, objects of some kind, make up some rules which must be obeyed and then you investigate all the possible results that might come from those rules.*

Pateman (1989) suggests that a person's philosophy of mathematics must influence their ideas on how one should teach. He further proposes that classes taken by a formalist will be places where the learning of rules is emphasised. The correctness of answers and the elegance of the solutions is paramount and applications are of secondary importance. 'That the material presented may be used to solve problems drawn from our experience is a kind of fortunate accident for the formalist teacher.' (Pateman, 1989, p.26).

Consequently, the difference in viewpoint leads to a difficulty in executing the course in a cohesive and integral manner. Each lecturer will offer a different version of the subject with different outcomes occurring.

Conclusions - breaking the chains and forming new links

The chains are not easily broken. One way of attempting to do so, is to invite students to act as researchers (Brown, 1994; Schuck, 1995). This allows them to develop their own questions about what mathematics is and what the implications of their beliefs, attitudes and practice will be for their teaching. If beliefs and attitudes are made explicit and open to discussion by the students' learning community, this should allow a multiplicity of perspectives to grow out of the views commonly held to this point. Students have an opportunity to discuss the limitations of the chains described above, and the option to change. Doing this as a community allows for guidance, support and reinforcement of the change. Consequently, the links between learners are formed and strengthened.

Another link that can help break a chain is the connection between different topics, concepts and areas of mathematics. Giving students the opportunity to work in their community to analyse the links between the content with which they are familiar and the underlying conceptual framework for this content will help to make the chain of limited subject knowledge disintegrate. Students investigate a problem co-operatively, share links that they might observe between the mathematics in that particular problem and mathematics from their past, and in this way, strengthen their subject matter knowledge. An example of this in the mathematics education subject under discussion is a variation of the question originally posed as the 'Grain of wheat problem': if one grain of wheat is placed on the first square of a chessboard; two on the second; four on the third; eight on the fourth and so on, how much wheat is there altogether? (This problem is given to our students as a problem about earnings over a period of time). The students pondered over the problem, and a diversity of methods were used to find the solution; some used calculators; some used a variety of patterns. One group identified a formula that they could use, which was dimly remembered from their past (the sum of a geometric series). They were absolutely delighted when they found that in fact they had derived the formula from first principles in their search for patterns. This was the linking of mathematics in a meaningful way for them. The integration of mathematics with other areas also helps students visualise themselves teaching in ways that do not stress the drill and tedium with which they grew up in the mathematics classroom.

Young (1992) has suggested that the purpose of education is to equip learners with problem solving powers in excess of their teachers. As we cannot adequately prepare students for the unknown future we need to prepare them in ways of approaching problems and using their community to reach accord. Breaking the chains and forging new links should move students towards this goal.

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