The three selves of the prospective primary school teacher of mathematics: An Australian case study

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The paper considers the way that a cohort of prospective primary school teachers engage with a mathematics education subject in their initial teacher education program. They appear to do so through the medium of three selves. This metaphor of the three selves is explained, and the implications of using this metaphor to promote positive interactions in mathematics education subjects are discussed.

Introduction

Prospective school teachers enter their initial teacher preparation courses with various experiences, beliefs and attitudes, many of which have developed as a result of their personal histories (Ball, 1989; Holt-Reynolds, 1994). The challenge for teacher educators responsible for mathematics education in initial teacher education courses is to help students make these beliefs and attitudes explicit, so that students may examine them and investigate their implications (McDiarmid, 1989; Holt-Reynolds, 1994; Schuck, 1996). It appears that mathematics education subjects in initial education courses do not always succeed in challenging students' thought about the nature of mathematics and the teaching of mathematics (McDiarmid, 1989; Ball, 1988). One of the reasons for this lack of success could be that the engagements between teacher educators and student teachers, or between the material of the courses and student teachers, are in fact, engagements with an inappropriate "self" of the student teacher. In what follows, I shall demonstrate that student teachers often have three selves operating in their attempts to make meaning of teacher education courses, and that for engagement with these student teachers to be effective, the appropriate selves must be addressed.

As a result of her research with prospective secondary school teachers enrolled in a content area literacy course, Holt-Reynolds (1994) suggests that student teachers "invent Self-as-Teacher based on what Self-as-Student believes" (Holt-Reynolds, 1994, p. 3), that is, prospective teachers constantly evaluate pedagogical ideas in terms of their own anticipated reaction to the ideas, had they been students.

This paper expands on the notion that student teachers respond to the beliefs of their "selves-as-students", by suggesting a model in which three aspects of student teachers' beliefs interact. The paper describes a study of the beliefs and attitudes of student teachers towards mathematics, and the teaching and learning of mathematics. In particular, it examines one of the findings of the study which suggests that many student teachers engage in three different ways with their mathematics education courses. The paper describes this phenomenon in detail and discusses the implications of this finding for initial teacher education courses in mathematics education.

The study

Participants and background

The study focused on a group of students, all within their first year in an initial primary school teacher education program at an Australian university. In their first semester, students were required to enrol for an orientation subject which covered the major learning areas encompassed by the primary school syllabus. The aims of the mathematics component of the curriculum orientation subject were to improve attitudes to mathematics; to broaden students' views of the scope of primary school mathematics; and to model some of the current approaches to teaching in the primary school.

In their second semester, students studied the first of a four subject sequence in mathematics education. In this subject, Mathematics Education 1, students covered three major areas of curriculum. The first dealt with learning theories in the area of mathematics education; the next section dealt with the historical development of our number systems and a discussion of the characteristics of some ancient numeration systems; and the last section dealt with topics from number theory. A problem solving

approach was used and a variety of mathematical models were suggested to develop new concepts. Cooperative learning was also encouraged. In this subject, emphasis was on concept development; the links between areas of higher order mathematics and primary school mathematics; the connectedness of mathematics; aspects of the history of mathematics which highlighted cultural influences on the development of mathematics; and development of understanding of the nature of mathematical activity, both by examining such activity as it has occurred in the past, and by engaging the students themselves in mathematical activity. It also aimed to increase students' competency in mathematics and to help students become aware of current theories about the learning of mathematics.

The students were all members of two tutorial groups out of a total of four groups in the first year cohort. There were approximately 100 students enrolled in the first year of the primary teacher education course. Fifty of these students were in the two groups participating in the study. Seventeen of the students in the study had been out of school for more than three years, the remainder had completed their school education within three years of attending university. The two groups were initially chosen because of my access to them as both researcher and lecturer in the first part of the study.

The majority of students had studied mathematics in their HSC, with over 60% at the 2 Unit or higher level. Consequently, these students could not be seen as innumerate in any way.

Methodology

Data for this study was collected by a variety of means. In phase I of the data collection, paired interviews were used. In these interviews the fifty first year students were asked to each formulate a set of five questions which would elicit from another class member their current attitudes towards mathematics and mathematics teaching and also indicate how these had been affected or influenced by past mathematical experiences. Students then answered each others' questions and results were audio taped.

The next phase of data collection involved obtaining responses from the same group to a questionnaire in which most questions were open-ended. The questions were developed from issues arising from the first phase of data collection and so were well grounded. In the third phase, in-depth interviews were conducted with eight of the student teachers at the end of their first year, in order to provide triangulation and to furnish further detail. All students in the two classes were involved in the first set of interviews and in the questionnaire; the eight students chosen for the second set of interviews were selected using the following two criteria: (1) an equal number of mature age students and recent school leavers and (2) a mixture of students in terms of their demonstrated ability to reflect on their teaching and learning. Finally, in phase four, four mathematics education lecturers were interviewed using an interview schedule developed from issues arising in earlier phases. For the purposes of this paper it was primarily the data collected in the third and fourth phases that was most informative, as it dealt with students' experiences in the teacher education subjects.

Data was analysed using the qualitative analysis software package NUD•IST. Data was coded according to a number of categories that emerged from a reading and re-reading of the data.

Results

The data was extremely rich and informed a number of different areas. This paper focuses on one result in particular. It became apparent from the way students talked or wrote about their learning in phases two and three, that they were viewing their own learning of mathematics, and their learning about pedagogical issues in mathematics education from certain perspectives. I have expanded on Holt-Reynold's model of "Self-as-Student" informing "Self-as-Teacher", discussed above, and consider the model with reference to a primary mathematics education context. The data in my study reveals that the student teachers reflected on, and informed their learning through the perspectives of three "selves". I have called these three selves "self-as-student-learning-to-teach", "self-as-primary-school-student" and "self-as-teacher". In Holt-Reynolds' (1991) study, the

student teacher decided whether Self-as Teacher would benefit from implementing a particular practice learned in the teacher education course, by listening to the responses of Self-as-Student undergoing the imagined activity. My data indicated that, for prospective primary school teachers, this inner conversation is strongly allied to the students' orientation to studies. I have classified students' orientations to their studies by using the framework suggested by Gibbs, Morgan and Taylor (1984). Gibbs et al suggest that there are four major orientations to study at university: academic, vocational, personal and social. Further, each orientation can be seen as extrinsic or intrinsic. My results indicated that students were very strongly vocationally oriented. A vocational orientation is described by Gibbs et al as follows: if students are intrinsically vocationally oriented, they are interested in the course as a preparation for their future career; if extrinsically vocationally oriented, they have chosen the course because the qualification is necessary for their future career. Consequently, because of the strong vocational orientation of the students, all subjects were judged for their value in preparing students to become good teachers.

In order to make this judgement in the mathematics education subject sequence, the students would assess the mathematics content from the viewpoint of self-as-primary-school-student, and this assessment allowed self-as-teacher to make a decision as to the value of the topic. If self-as-teacher would use that topic in her/his classroom, then the topic was assessed as worthy of time and effort and was regarded as a useful topic to study. If self-as-teacher could not envisage teaching that topic, the topic was regarded as worthless, and discarded. Self-as-teacher made the decision about the topic by consulting self-as-primary-school-student. If self-as-primary-school-student could cope with the demands of the work, and the topic agreed with self-as-teacher's notions of what mathematics should be taught, the topic was given the validity that it required, in order to be learnt by the student teacher.

Consequently, the data suggests that for many prospective primary school teachers, there are three selves that are consulted: self-as-primary-school-student, self-as-teacher, and self-as-student-learning-to-teach. From the discussion above it can be seen that self-as-primary-school-student tests the content in order to advise self-as-teacher. If self-as-teacher is convinced of the worth of the content, then self-as-student-learning-to-teach finds value in the content in the mathematics education subject.

The following extracts from the data all illustrate the constant use of the filters of self-as-primary-school-student, self-as-teacher and self-as-student-learning-to-teach. Maria, in the phase three interview (all names are pseudonyms to ensure anonymity), was asked whether she would have studied the mathematics education subjects if they had not been compulsory. The conversation continued (the italics are added for emphasis):

> Oh yeah, I'd definitely do it, ...because I'm not very strong in maths I'd do it *just so I can build up a strength.* Because I mean that's something that they really need to know and you want to teach it well, especially mathematics.
> Question: And did you feel that you got any help in that direction in the first year mathematics, Mathematics Education 1 in particular?
> Answer: Um, oh I learnt a few new little skills and ideas *but I didn t really use them on prac*, I mainly used the syllabus, like that really helped more, my supervising teacher went by the syllabus so I used that, but some things, ..yeah some things I found interesting.

Maria first said that she felt it was important for her to build up her mathematics, yet when asked whether the Mathematics Education 1 subject had helped her achieve that aim, she answered a different question: was the subject content useful on the teaching practicum? So Maria appeared to see building up subject content knowledge as purely developing content knowledge of the current NSW primary school syllabus, as indicated by the NSW K-6 Curriculum Document. Here self-as-teacher is evaluating the content of the subject Mathematics Education 1 by judging its worth as material to be taught on the practicum. Self-as-student-learning-to-teach is then advised as to its value.

Another student, Terry, in her phase three interview, discussed studying the ancient numeration systems in Mathematics Education 1. It should be noted here that the ancient numeration systems were taught to students for a variety of reasons: to help students see what made a numeration system efficient in a particular context; to show how mathematics developed in a socio-cultural context and was dependent on the needs of the society in which it was situated; and to isolate the underlying principles of our place value system. Further, study of different numeration systems was recommended in the Discipline Review of Teacher Education in Mathematics and Science (DEET, 1989). However, Terry did not seem aware of these reasons:

> ... and the second semester I didn't think was as practical, we did all those different numeral systems and I just really didn't see where they were used as much. But I didn't think it was ... I didn't think primary school ... I don't think I would have understood it, when I was in primary school.
>
> I don't know, I don't know why we did that. I didn't know why, I didn't really see the point. I didn't mind it, because I'd never done that, but I just didn't think ... I didn't think, I wouldn't do it with my primary school class.

Terry evaluated the worth of the topic by assessing it as self-as-teacher. To do this she first put herself into her self-as-primary-school-student position and decided she would not have understood the concepts. This then linked to her assessment as self-as-teacher: it was not a useful topic. Consequently, she did not see any reason for being taught the topic in Mathematics Education 1 - if a topic was not going to be taught to primary school students, then self-as-teacher advises self-as-student-learning-to-teach that there is no value in studying this topic at university.

It was apparent from the text that Terry seemed quite unaware of any other reason for studying the topic in the mathematics education sequence. It is possible that the teacher educator who took Terry's class for this subject had not felt it was necessary to convince the students of the value of the topic, but might have regarded the intellectual challenge inherent in the study as sufficient reason for studying the systems. This belief highlights the need for teacher educators to address self-as-teacher in their mathematics education classes. The following comment from one of the other students in this class illustrates this:

> We really didn't know why we were doing it and so a lot of the good was lost, it wasn't being reinforced, it wasn't being consolidated, it wasn't being tied in with the base ten or with children.

Further the students were reinforced in their belief as self-as-teacher, that studying the ancient numeration systems was not of any value, as it could not be used in the school. Supervising teachers on the practicum dismissed any lessons students might have prepared on the ancient numeration systems as irrelevant and wasteful of time:

> ...we were actually doing all the Egyptian [numeration system] and everything when we went out on our first prac and I thought this will be terrific you know, we really can tell the children all about the history of mathematics and they can understand it all more and they can get really excited about it too.
>
> And of course, the teacher said "Oh, are you doing that rubbish? That's just absolutely ludicrous, you know. We'll get on with this, there's too much to cover in the curriculum without all that" and so that was squelched...
>
> That reinforces something in my mind, it reinforces that what we're doing at university is so totally unrelated to what happens in reality in schools, where do you tie them both in? That's what it reinforces. (Gail, Phase three interview).

The student's self-as-teacher accorded the supervising teacher a very high status and seemed to derive valued information from the supervising teacher as well as from self-as-primary-school-student. As a result, the student's self-as-teacher received confirmation that the topic was not going to be useful: a "real teacher" had indicated that it had little

value in the primary classroom. This confirmation for self-as-teacher, together with the fact that the topic was not evaluated for its usefulness in any other context but that of the primary school classroom, led to a perception by self-as-student-learning-to-teach that the topic was without any value.

On the other hand, some topics were seen as worthwhile by self-as-student-learning-to-teach, because self-as-teacher could see value in them. A study of number patterns was one of these for Terry;

> The patterns were actually not too bad because I thought that they were more practical. I thought, you know, you see patterns in things and I thought that was useful for children to be able to look at something and see a pattern ... I think that's useful.

Students were also asked questions about their strategies for studying mathematics at university, in the first year mathematics education subject. As indicated above, where students saw the value of the topic they were studying, they made some effort to understand it and to investigate it at depth. The value of the topic was judged from the perspective of the self-as-teacher. It was judged to be worth studying if it was perceived as a topic that would help the student become a better teacher of mathematics at primary school level. The following extracts from the data illustrate how students studied Mathematics Education 1, by first filtering the content through their selves as primary school student and teacher, and then by choosing the most appropriate learning strategy available to them for the particular assessment. To some extent when the material was not considered useful, motivation came from extrinsic vocational orientations; the qualification was needed and so the subject was studied sufficiently to achieve a passing grade. It should also be noted that students did not always have a very large repertoire of appropriate learning strategies for studying mathematics content. Much of their learning in the past had comprised only rote learning and reproduction of facts and formulas; other learning strategies were often lacking.

For Terry, self-as-teacher saw that most of the topics had value for her teaching and so she prepared herself quite thoroughly:

> ... because I knew that it would be needed, not just for the exam, but to do that topic, and it might help me understand that topic more or have suggestions on how to teach it or what children find hard in that topic or whatever they had to say about it.

On the other hand Aaron exhibited extrinsic motivation and this affected the way he studied the subject:

> ... I thought "God, I've got to pass this exam" and then I thought "*!?* it, I'm not going to spend, you know, too much time on it". No, I thought it was enough to understand enough to pass. That's pretty well the way we worked, I think. None of us were really that concerned about getting high marks, we just wanted to pass, which is, I suppose, the wrong attitude, but at that stage of the year that's really all we felt like.

The reason that Aaron exhibited extrinsic motivation rather than intrinsic motivation is because his self-as-student-learning-to-teach could not see the value of the work when judging it as self-as-primary-school-student and self-as-teacher.

> ... especially for us, because a lot of us had trouble understanding it, and I thought, you know if we don't understand it, how are these kids going to understand it. Then we got to this stuff and we just didn't understand it, nothing, nothing clicked and we thought "Oh, what the hell, none of us are going to teach this.

Self-as-primary-school-student considered whether the work was conceptually accessible, and advised self-as-teacher that it was too difficult. Self-as-teacher then discarded the topic and advised self-as-student-learning-to-teach not to spend time on that topic as it had no value in the primary school classroom.

Finally, the teacher educators seemed to be aware to some extent of these internal conversations and expressed concern about the stance held by self-as-teacher.

> I think that it's always a great worry that our students ... are still making these kinds of comments: "Will we be teaching this?" rather than "What's the relevance?". If they asked you what the relevance of it was, that's a good question, and you can discuss that, but when they ask "Will we be teaching this?" and you have to say no, they might say "Well, what's the point?", which is a pity. (George, teacher educator, phase 4)

Discussion and conclusions

The very strong vocational orientation of the students led them to filter all content of the mathematics education subject through their three selves. This process led students to select those mathematical topics that were both highly accessible to self-as-primary-school-student and also appeared to match self-as-teacher's vision of appropriate mathematics for the primary school classroom. Consequently, any mathematics that did not explicitly address these criteria tended to be neglected by the majority of the students, as they were not prepared to devote any cognitive effort to the study and understanding of what appeared to be irrelevant topics. At the same time, students were reluctant to spend valuable time learning topics that did not fit the needs of self-as-teacher, and wanted, instead, to spend that time learning how to teach topics that self-as-teacher was nervous about explaining to children, such as long division. These feelings led to a devaluing of the mathematics education curriculum by many of the students.

This highlights a difficulty that arises from self-as-primary-school-student constantly evaluating the topics. Prospective teachers often have a very narrow view of the mathematics that could or should be done by primary school students. Past experiences have often closed students' minds to the possibilities that exist in primary school mathematics, and also encourage prospective teachers to place ceilings on the sorts of activities that might be done in a primary school classroom. The selves-as-primary-school-pupils are, in fact, projections into the past by the students themselves. Their experiences in the primary school classroom have led them to accept as authentic activities, that self-as-teacher would teach, either activities similar to their past experiences, or activities that promise to be highly enjoyable, regardless of whether learning occurs or not. As a result, self-as-student-learning-to-teach expects the topics covered in the mathematics education subjects to be either extremely familiar, or fun to do. For the latter, the many unsuccessful experiences that some of these students have had in the past suggest that the cognitive demands of the mathematics must not be extensive if students are to enjoy the topic, as their lack of confidence is always near the surface, and will emerge at the first sign of difficulty. These views can create conflicts between the aims that student teachers have for their mathematics education subjects and the aims of the teacher educators.

There are implications of these internal conversations, and the consequent valuing of mathematics education subjects, for mathematics educators in teacher education programs. It becomes essential for the teacher educator to address the three selves of the student teacher rather than merely bemoan the fact that they seem to exist. If self-as-teacher and self-as-primary-school-student exert such a strong influence on self-as-student-learning-to-teach, then they too must be invited to participate in the discourse on learning and teaching. This participation should occur in choosing the curriculum for mathematics education subjects, so that topics are chosen which have clear applications to primary school classrooms and are also easily accessible to the majority of student teachers. Much of the primary mathematics curriculum can be used as a starting point for the study of mathematics that is connected, rich and deep, and at the same time has clear relevance for self-as-teacher and accessibility for self-as-primary-school-student. Further, the reasons for which teacher educators have chosen particular topics to be studied need to be clear to the student, and these reasons need to be linked to the aims held by self-as-teacher and self-as-primary-school-student in order to motivate self-as-student-learning-to-teach.

Consequently, it is necessary for teacher educators to be aware of the internal conversations of student teachers, and to negotiate a curriculum with the three selves of

the student teacher, that both student teacher and mathematics educator believe is capable of achieving their diverse aims.

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