Using self-study to challenge my teaching practice in mathematics education

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As a teacher educator continually trying to improve my own practice I have engaged in self-study for many years. However, I have come to think about self-study in different ways as I have become involved in the reform movement in mathematics teaching and learning. It has become clear to me that self-study not only has the capacity to improve personal practice but also to contribute to the reform of teacher education practices in general. To do this, serious self-study must use research methods which are rigorous and thorough.

In my self-study of teacher education practices I discovered that it was essential for me to be familiar with my students' beliefs as well as my own. I found that prospective primary school teachers often held beliefs about mathematics teaching and learning that constrained their access to rich and powerful ways of learning. My practices consequently needed to be revised to help students challenge these beliefs. However, careful study of my new practices also revealed some obstacles.

By increasing the depth and the rigour of my self-study of my own practices as a teacher educator I have become aware of both pitfalls and opportunities in my approaches to supporting my students' learning. In the paper I suggest several conditions that need to exist if self-study of teacher education practices is to be a fruitful activity for those engaged in the demanding task of challenging students' beliefs.

In this paper I explore the notion of self-study and the ways in which rigorous study of my practices as a teacher educator in an Australian university helped to challenge both my views about teaching and learning, and the views of my students. Although self-study has gained increasing recognition in recent years (for example, the Self-Study of Teacher Education

Practices Special Interest Group of the American Educational Research Association, S-STEP, is the largest growing Special Interest Group of that Association (Zeichner, 2000)), the nature of self-study research remains complex (Bullough & Pinnegar, 2001) and open to individual interpretation. Indeed, it is the very nature of self-study that works against the provision of a set of explicit underlying principles for such study. Loughran and Northfield (1998) have suggested some starting points in evolving our understanding of what self-study comprises (pp. 11-16). I have selected the more substantive of these suggestions and grouped them together into two major areas. I discuss them below:

1. *Self-study is defined more by the focus of the study than the way in which it is carried out.* Various methods may be used in self-study but the focus in all cases is on how personal practice in teacher education can be improved and the implications of such improvements for teacher education in general. Although Loughran and Northfield suggest that quantitative and qualitative methodologies can be appropriate in self-study, it appears to me that action research, reflection, narratives and autobiographies are more appropriate methods than are quantitative methods which generally answer different sorts of questions. Loughran and Northfield further suggest that the focus on the study is constantly changing as modifications are made to the practice as a result of the study.
2. *Self-study is strengthened by being collaborative*. Data needs to be checked with others. The role of the critical friend is important in assisting with the interpretation of data. Different viewpoints are brought to the situation by students and colleagues.

In this self-study, I found that the discussion above resonated with my experiences. Firstly, my study was of my personal practice but had the dual aims of considering how my practice could be enhanced and also how such a study could be of value to other teacher educators and

to teacher education in general. My aim in writing this paper is in full agreement with the suggestion made by Bullough and Pinnegar (2001) that self-study research needs to balance the personal story with the broader context, to focus on "the space between self and the practice engaged in." (Bullough & Pinnegar, 2001, p. 15). A fundamental principle underlying my self-study was the need to examine my practice from other viewpoints than the one I had initially brought to the study. I also grew to understand that while self-study of teacher education practices involves the examination of a person's practice for purposes of improving that practice, this purpose is not the only reason for self-study. The other purpose is to develop deeper understandings about teacher education in general; to produce and advance the knowledge about teacher education (Friesen, 1997). In this paper I suggest that a deep understanding of the context and the beliefs of students who are being taught is essential if self-study of teacher education practices is to contribute to reform in teacher education. It is in this way that my self-study research is placed at "the intersection of biography and history" as discussed by Bullough and Pinnegar (2001).

Secondly, I view my study as collaborative although I am using the word in a more general sense than is usually done. It was collaborative in that the viewpoints of my students and those of the education research community in which I locate myself were important in challenging the views that I held about my practice. While I did not directly have a "critical friend" to interpret my data with me, my reading, feedback from my research supervisor and comments by my students all served as checkpoints for my reflection and analysis of my data about my practice.

This paper deals with my journey of self-study over the last 15 years as I started initially to seek validation of my existing theories about learning and teaching mathematics through

reflective inquiry, and later found that these theories were being challenged through a deeper and more formal investigation of my practices. For me, it is interesting that the clash of paradigms that I have been experiencing personally in the development of my own theories of learning and teaching mathematics in an Australian university, reflects to some degree the large-scale clash of paradigms being presently experienced, particularly in the United States, in the so-called Math Wars, where those engaged in implementing reforms in mathematics education (for example, the National Council of Teachers of Mathematics (NCTM)) are engaged in heated debates with others, who feel that the reform movement is impeding the development of mathematical knowledge for many (for example, the Mathematically Correct Society). While the NCTM encourages teaching in ways, and using content, that are accessible to more people, other groups call for a return to the development of basic skills in the use of algorithms and procedures, and more teacher-centred methods of teaching.

In this paper I trace my development as a teacher educator in mathematics education. I used a variety of established research methods in my enquiry, but added to these my reflections and analysis of my responses to the representations of my own experiences and those of my colleagues and students. In this analysis I am presenting my research in ways that recognise "the 'struggle' of learning" (Lomax, 2000). It is this emphasis as researcher on my meaning-making of my practice that locates this study as a self-study.

Through my self-study I became aware of the limitations of self-study without recognition of the broader picture of the context, in similar ways to Bullough and Pinnegar (2001). I therefore discuss the revelations that I experienced which led to changes in my practices due to deeper self-study and I consider the implications of those revelations for the practice of self-study.

Teaching as telling: Myself firmly in control

My story started approximately 15 years ago when I first started teaching in a teacher education program, having moved from teaching in a secondary school to teaching in a tertiary education institution.

Mathematics education was then, as it is now, my passion. I believed, and still believe, in the right of **every** person to have successful and fruitful experiences in mathematics education, at least up to the end of secondary schooling. I felt that the understanding of concepts underpinning much of mathematics was essential, as a first step in the appropriate and efficient use of algorithms and processes. However, I had at that point in time, a belief in the role of the teacher as the expert, clearly explaining concepts to others and managing a very teacher-directed class. As teaching mathematics in ways that were accessible to all was a founding principle of my thinking and approaches, I evaluated my students' learning carefully by assessing whether they had achieved the cognitive outcomes I desired through assessment tasks, and by asking them to evaluate my teaching through surveys developed by our university's Centre for Learning and Teaching. My methods of evaluating my teaching were consistent with my assumptions about teaching as telling.

By considering the grades that students obtained and their feedback on my teaching, it appeared that students were doing well in their assessments and were generally very happy with my teaching approaches. The student evaluations were extremely positive, giving me scores well above the faculty, and indeed university averages, for each aspect of my teaching. As I was experiencing no conflict between my theories of learning and teaching and students' reactions to them, I continued teaching in this manner for a number of years.

Researching my own practice

I believe that in focusing only on my practice in the above stage of my teaching, I neglected to consider the broader implications of my approaches. While acting as a "good practising teacher" I did not see my role as a "scholar teacher" (Turney and Taylor, 1996) or researcher. It was only with the support and encouragement of my academic supervisor, that I began to see my role as a teacher could be enhanced by my research and self-study of teacher education practices.

I began doctoral studies and the process of research and the results of these studies led me to a crossroads in my beliefs about teaching and learning mathematics. The process of undertaking a deep research study, with its corresponding emphasis on a thorough understanding of the relevant literature, acted as a catalyst for me in the process of asking questions about my teaching. I started asking different and deeper questions about my practices. These questions became more powerful than my students' feedback as they challenged my aims for my teaching. The literature suggested new ways of teaching to me. It also discussed the consequences of transmissive teaching. My research methodology allowed me to probe students' beliefs in much richer ways than the evaluative surveys used previously. I gained new and different insights into student beliefs.

The study: Learning what my students were actually learning

My research investigated the beliefs and attitudes of prospective primary school teachers with respect to their learning and teaching of mathematics (Schuck, 1996). Fifty students in the first year student cohort of one hundred were participants in the study. Data collected were:

- questions that students had developed and posed about issues in mathematics education in which they were interested,
- responses by other students to those questions,
- a open-ended questionnaire in which I further developed emerging themes from their questions and responses,
- in-depth interviews with eight of the students
- in-depth interviews with the mathematics educators responsible for teaching an introductory mathematics education subject. The data from these interviews included my responses to the interview questions as well.

My findings, which certainly corresponded with other researchers' findings of the time (for example, Ball, 1988, 1990; Foss and Kleinsasser, 1995, 1996), were that prospective teachers' beliefs about teaching and learning mathematics were major inhibitors of their own learning and of their ability or desire to facilitate the learning of others in the mathematical area. Prospective primary teachers often believed that you had to have a "mathematics brain" to be able to do mathematics, and that "mathematics wasn't for people like us, it was for the smart students" (Schuck, 1996). These views led many of them to learn the mathematical content by rote as they did not have the confidence to engage in a cognitive interaction with the content. They also had clear and strongly held ideas about teaching: a good teacher explained clearly and gave opportunities for a great deal of practice; similar beliefs to those I had held before I started this study. One of the consequences of holding such beliefs was that a strong emphasis on teaching as telling did not allow for much flexibility in methods of teaching or for idiosyncratic ways of solving problems (Schuck, 1996).

My analysis of my response to the students' beliefs about the teaching of mathematics highlighted a contradiction in my thinking (Whitehead, 2000). This contradiction was that our (shared) ways of teaching seemed to obstruct ideas of access for all, and of learning as a social and situated process, dependent on past experiences and contexts. Further study and investigation of the theories of learning espoused by constructivists and socio-cultural theorists directly challenged my previously held views and led me to develop new personal theories of learning and teaching which acknowledged that learning was not transmissive but an active process by the learner (Ernest, 1991; Perry & Conroy, 1994). I came to believe that learning was very much a socio-cultural activity (Cobb, 1994; Dengate and Lerman, 1995) in which the context and the interaction of others were major influences in any one person's learning.

Through my reading of the above literature, and my careful analysis of this literature and its implications for my teaching, I started developing a different theory of learning which had implications for my practice. As I wrote my doctoral thesis and constructed arguments that proposed that socio-cultural theory underpinned learning, it became apparent to me that my task as a mathematics educator was to help students become aware of their beliefs and the implications of these beliefs for their teaching and learning. I started to understand that my teaching as telling, while comfortable, confirmed students' existing beliefs about mathematics education, and did not encourage change in their thinking. I became convinced of the value of participatory learning in which students were encouraged to take more control of their own learning. I developed an intervention (Schuck, 1997) in which I encouraged students to think as researchers, examining their own beliefs and reflecting on the consequences. I began teaching mathematics content in participatory and investigative ways - by setting up rich environments in which students could investigate, debate and justify their reasoning to one

another. I introduced new topics into the curriculum for the primary student teachers, which were suggested by the National Council of Teachers of Mathematics (1989) as accessible topics, useful for demonstrating the nature of mathematics. My practice involved virtually no telling or lecturing. Students carried out tasks, and then explained to each other how they had reached various conclusions. Historical and social aspects of mathematics were emphasised as were different approaches to learning. I became very critical of my previous practices and saw them as indicative of a lack of critical thinking about my practice and my aims for my teaching. I felt that my earlier practice had supported my aim of being viewed as a good teacher and having appreciative students, but had not supported my aim of challenging students' conceptions of mathematics or of offering them different ways to view their future practice as teachers of mathematics in primary schools.

Evaluations of my new ways of teaching were mixed. Most students acknowledged that these methods were beneficial and that they wished they had been taught in these ways while at school. However, a few of the students suggested that such methods were not appropriate for them at this stage of their learning, and that they benefited far more from exposition and clear indications of how to conduct particular lessons. Indeed I had neglected to take account of the power of their life histories. Like me, students had gone through a school system in which they had been taught in transmissive ways – they had developed a vision of teaching and learning that was based on their experiences. Unlike me, they had not had the opportunity to think deeply about their views or see the implications of their beliefs in the context of mathematics education reform. For these students, the intervention they experienced in my class was not sufficient to overturn years of experience. Further, filled with my newfound convictions, I was evangelical in my approaches. Convinced that my new approaches were truly beneficial for all students I did not offer choice in approaches. I imposed my thinking

on the students in the belief that they and their future students would gain from these new ways of thinking.

Criticisms from some students of the new approaches became apparent in interviews I had with them towards the end of my data collection for my doctoral research. Many students felt that it was inappropriate to learn about the cultural context of learning in mathematics as they felt that this was not directly related to the knowledge they needed to teach in an primary school. These views were reinforced by experiences in primary classrooms. When student teachers brought their new found learning to the classrooms in which they were placed for field-experiences, their school-based teacher educators, classroom practitioners, often were dismissive of their learning. These teachers would suggest that authentic learning, seen by them as the learning that took place in schools, was very much of the sort I too had practised previously - of teaching as telling and clear exposition followed by drill and practice, and of content from a syllabus that was traditional in manner. However, at that stage, influenced as I was by the literature I was reading and reviewing, I felt that these views merely needed more time and they would change.

As I continued my self-study, which involved carefully reading what students had written about the subject and about their beliefs, I became aware that I needed to make the subject matter more explicitly linked to the content of the school curriculum. The students' strong vocational orientations were often their major motivations for studying in our program. If they felt the subject matter would achieve their vocational aims, they were motivated to study it. Recognising that this vocational orientation was the driving force for many of the students highlighted the need for me to modify the subject matter so that it would be more relevant for them. However, the student input also alerted me to a disturbing realisation that embracing

socio-cultural or constructivist theories of learning often meant that students interpreted the cognitive aspects of learning mathematics as almost unimportant, compared to the primary need to experience fun in mathematics classrooms.

Having fun in the mathematics classroom: an oxymoron?

It has been noted in the literature that for many teacher educators involved in reform of teacher education, the desire to challenge students' beliefs about learning and teaching, and to shift these beliefs away from transmissive models and towards constructed models, may be responsible for a downgrading of the value of subject matter knowledge in these programs (Floden, McDiarmid and Wiemers, 1990). In the case of mathematics education in our program, the majority of teacher educators involved in the program believed that it was important to shift students' thinking. However, none of them (including myself) believed that the subject content knowledge was of lesser importance. Nevertheless, it appeared that students, being acutely aware of their own struggles with the content matter of mathematics, were relieved to learn about theories in which the role of the teacher is not that of an expert but rather of a facilitator who learns with the students in the classroom. Students saw the implications of this type of role as being that teachers did not have to be very knowledgeable about subject content matter provided they were enthusiastic, empathetic and supportive.

While the latter qualities for a teacher were emphasised in our teaching, the teacher educators involved in the development of mathematics education programs for the student teachers all (myself included) strongly believed that students needed to understand the conceptual underpinnings of any mathematics they were going to be teaching to future students. I found Shulman's framework (1986) of a number of different content knowledge categories very

useful in the development of my theories about teaching and learning. These content knowledge categories included:

- pedagogical content knowledge, or knowledge of the content that is most appropriate for children to learn, knowledge of which avenues are fruitful to explore and what aspects of the subject matter tend to be problematic
- subject matter knowledge or knowledge about the actual subject matter, including understanding the underlying structures and concepts of the subject
- curricular knowledge or knowledge of what comprises the curriculum and what materials are associated with curricular knowledge as well as other knowledge about the curriculum.

However, in researching my practice with my students, I did not find evidence of a shared valuing of all these categories of content knowledge. Rather, I found that the emphasis on empathy and nurturing completely overshadowed many students' belief in the importance of subject matter knowledge. In fact, some students indicated that they felt it was almost a disadvantage to be knowledgeable about mathematics as this ease of understanding would prevent them from being able to empathise with their students' struggles with the material being taught (Schuck, 1999).

My self- study of teacher education practices had once again led to a conflict between the theories of learning and teaching which I held. On the one hand I believed that prospective teachers were obliged to make mathematics accessible to all their future students, and that methods of participation, collaboration and investigation were highly appropriate for enhancing this access. On the other hand, I felt that it was extremely important for student teachers to have a strong understanding of the concepts underlying any of the activities they developed for school students, and a grasp of the methods and nature of mathematical

endeavours. While continuing to believe that students' beliefs about mathematics and mathematics teaching and learning needed to be made explicit and that students should be given the opportunities to examine these beliefs and consider their implications, I also became aware of the need to emphasise the importance of subject matter knowledge as suggested by Shulman. However, my belief that students should have a deep understanding of the subject content underpinning the topics that they would be teaching sometimes led to a collision with my belief that my students should be able to experience mathematics classes in a way that was anxiety free and enjoyable. Most of the students had little confidence in their mathematical abilities and did not enjoy engaging with the mathematics content. So my insistence on the value of content knowledge often led to a reversion in their attitudes towards mathematics.

Through engaging with my students in this self-study, I gained valuable insights into their feelings and beliefs, some of which had arisen as a result of my practices. To me, this dilemma is a case study of the conflict in mathematics education occurring today and referred to earlier. My way of resolving it has been to ensure that the subject content matter we deal with in classes is both highly relevant to the teaching of primary mathematics and also accessible to all students. To an extent, this has led to disagreement with some of my colleagues who believe that we should ensure a higher level of understanding of mathematical content. It is my belief that having an understanding of primary school mathematics and an interest and confidence to investigate further will be more beneficial in developing mathematical understanding in the long run. As primary school teachers, my students will learn more mathematics as they need it: but only if they have the confidence to pursue this knowledge rather than avoid it. Meanwhile, I continue to strive to both challenge my students' beliefs about mathematics and to engage them in developing their understandings of the content.

Learning about teaching through self-study

The self-study gave me a number of insights that are of value in teaching student teachers how to teach mathematics. I share these with the reader in the hope that they will be of benefit to other teacher educators in a variety of discipline areas:

- It appears extremely important for teacher educators to be aware of the beliefs and views of their students about learning and the nature of learning in particular subject areas. Before investigating the beliefs of my students my beliefs and practices went unchallenged even though I was reflecting on my teaching and asking students to evaluate my practices. I was unaware of the ways in which my students' beliefs supported our mutual desires to maintain the status quo. While acknowledging the importance of being aware of students' evaluations of our teaching and of the need to take these into account in modifying our practice, I needed an awareness of the beliefs held by both the students and myself that underpinned these evaluations.
- Student evaluation feedback on its own is insufficient in directing reforms, as most people are initially resistant to change. Encouraging students to choose how they are taught, without giving them the opportunities to investigate other approaches or reflect on the benefits and disadvantages of a variety of approaches means that known models will be privileged over the unknown.
- Emphasising approaches to learning which incorporate attributes of collaboration, support and enthusiasm are not sufficient for good teaching: the importance of content matter knowledge as delineated by Shulman needs to be emphasised.

Learning about self-study through self-study

As a result of my journey of self-study, and in the light of the discoveries that I discuss above, I offer the following observations about self-study:

- Self-study has to be rigorous to be of any significance beyond individual practice. By this, I mean that it has to be thorough, use appropriate research methodology to ensure all voices are heard, and it needs to be well documented. Otherwise, the danger occurs of merely asking questions whose answers will confirm existing beliefs. In my self-study, getting feedback from students that I was meeting their requirements for an educator, only gave part of the story. I neglected to consider the implications of maintaining the status quo and only became aware of this when I entered a more rigorous study of my students' beliefs and views about mathematics.
- Awareness of the literature about the area being studied as well as the context of the self-study is essential for the self-study of teacher education practices to have any far-reaching benefits. Entering into a community of practice in mathematics education led me to contemplate new approaches and new theories, which in turn led to my developing new practices and sharing those practices with others. Thus, as with any research, self-studies should be widely disseminated so that practices are examined by the academic community and held up for critique as is other research. In this way, self-study avoids the danger of being solipsistic.
- Self-study is never complete – changes in context, student body, and cultural practices will all suggest corresponding changes in teacher education practices. This final point suggests to me that deep and ongoing self-study of teacher education practices is essential if any teacher educator is to be a leader in reform of practices.

It appears that a major obstacle to reform in teacher education occurs if a teacher educator engages in self-study in isolation from his or her colleagues, either by choice or because of the lack of interest of the colleagues. Those not involved in serious self-study may obstruct the changes suggested to individual teacher educators by their self-studies (Myers, 1995; Russell, 1999). Participants in the self-study of teacher education practices movement have a role to play here in publishing their research on self-study to promote its benefits and significance. Also, as self-study of practices often leads to discomfort for both teacher educator and students, a climate in which such challenges to practice are rare and unsupported will encourage the status quo and inhibit change. Therefore, the presence of colleagues who are able to act as critical friends are important in the development of authentic self-studies, which genuinely study practice rather than confirm existing beliefs.

On a personal note, my examination of my journey of self-study suggests to me that I should not allow myself to be seduced by the easy route, the route on which students would like to steer me. By persevering with ways of increasing student autonomy and by continuing to assess my practice, not merely from student evaluations, but also from examinations of students' learning and teaching of mathematics and beliefs about mathematics, I will gain valuable insights into how to be a more effective teacher educator.

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