Multiple Learning Contexts: A Vehicle for Changing Preservice Primary Teachers' Mathematical Beliefs, Knowledge, and Practices

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This paper reports on the initial findings of a longitudinal study aimed at investigating the impact on preservice primary teachers' mathematical beliefs, knowledge and practices of a mathematics education course utilising a situated learning perspective. Other research in this area has found that preservice primary teacher's beliefs have remained unchanged as a result of their teacher education programs. Preliminary findings from this study contradict these results. It is suggested that the utilisation of a multiplicity of learning contexts may explain this discrepancy.

There is a growing number of studies confirming the influence teachers' mathematical beliefs play on their classroom practice (Buzeika, 1996; Ernest, 2000). In regard to preservice teachers, it is widely accepted that they enter their teacher education studies holding 'traditional' views on how to teach mathematics and what mathematics should be taught (Benbow, 1993). These views, in part, are acquired from the preservice teachers' personal experiences based on literally hundreds of hours of listening and observing mathematics school teachers. Unless challenged, such views ensure that the traditional model of teaching mathematics is perpetuated.

During the past 15 years the notion of constructivism has challenged the traditional model of teaching and learning (Klein, 1999). In relation to the discipline of mathematics, it has challenged both the nature of mathematics (dynamic versus static) and how knowledge is acquired (actively versus passively). In response to growing support for teaching mathematics from a constructivist perspective (Australian Education Council, 1990; DEET, 1989), a number of teacher education programs adopted a constructivist approach in the way their courses were delivered. According to constructivist principles, this translated into establishing a learning environment in which students construct their own knowledge by linking prior experiences (including knowledge and beliefs) to new knowledge (Jones & Vesilind, 1996), creating 'learning communities' in which students engage in rich discourse about important ideas (Putman & Borko, 2000) and using reflection as a powerful vehicle for reconceptualising knowledge and beliefs (Beattie, 1997). It was anticipated that such modelling of a constructivist approach within preservice education programs would translate into classroom practice (DEET, 1989).

Whilst many teacher education programs reflected a constructivist approach during the 1990s (and continue to do so), accumulating evidence indicates that it has not translated into classroom practice as expected (Foss & Kleinsasser, 1996; Fuson, Carroll, & Drueck, 2000). Furthermore, studies by Foss and Kleinsasser (1996) and Klein (1999) concluded that not only do preservice primary teachers' mathematical beliefs remain unchanged as a result of their teacher education but that their conceptualisations of mathematics and themselves as teachers of mathematics do not change either. Such findings directly contrast the initial findings of the current investigation.

The current investigation was undertaken after anecdotal evidence relating to the mathematics education courses taught by authors of this paper directly contradicted the disappointing findings emerging from such studies as those cited previously. Hence, the intention of the current study was to explore the impact of a mathematics teacher education course on the mathematical beliefs, knowledge and practices on preservice primary teachers in an attempt to identify factors which might be more successful in inciting them to modify their beliefs and begin reconceptualising their views of mathematics. While not part of the current report, it was also intended to investigate the extent to which this impact was translated into classroom practice during a ten week internship.

It was hypothesised that such changes in preservice primary teachers' beliefs and knowledge were the result of undertaking courses in mathematics education which, whilst supporting a constructivist approach, also addressed a *situated* perspective on learning (Greeno, 1997). One aspect of this perspective values the context in which learning occurs. As noted by Putnam and Borko (2000, p.4), situative theorists place importance on the physical and social contexts in which an activity occurs: "the physical and social contexts in which an activity takes place are an integral part of the activity, and (that) the activity is an integral part of the learning that takes place within it". It is suggested that a preservice teacher attempting to translate theory into practice outside of the classroom context—the 'real' situation—may in fact experience difficulties in transferring their knowledge from one context to another (Brown, Collins & Duguid, 1989; Richardson, 1996). It was hypothesised that by providing multiple contexts for teaching and learning as part of the preservice teachers' mathematics education courses the issue of transfer would be addressed.

In the case of preservice primary teachers, knowledge is usually situated in either the university or the K-6 classroom. However, a common practice in the primary mathematics teacher education program in question is the utilisation of two other contexts. The first additional context involves pairs of preservice teachers working with small groups of children in schools on a weekly basis while under the direct supervision of a mathematics educator. The second additional context involves children with special needs in numeracy attending the university twice a week for individualised instruction by a preservice teacher. This again occurs under the supervision of a mathematics educator. Such experiences are considered opportunities for the mathematics educators to facilitate preservice teachers' enactment of new beliefs, knowledge and practices.

Methodology

Two types of data gathering tools were used in this project. They were concept mapping and semi-structured interviews. Concept mapping was the primary tool for gathering information on existing beliefs about mathematics and for noting changes to the pre-service teachers' beliefs and knowledge during the course of the Master of Teaching program. This data gathering tool has been used in a number of studies designed to investigate changes in beliefs and professional knowledge over time (Bobis, 2000; Novak & Gowin, 1984). It has been found to be particularly useful from a constructivist framework where one is seeking individual insights (Trowbridge & Wandersee, 1994). When used in

conjunction with interviews it provides a valid tool for comparing data from different sources (Laturno, 1994).

Semi-structured interviews were used to clarify and strengthen information gleaned from a participant's concept map. They allowed participants to elaborate their thinking.

All concept maps were redrawn using a drawing program and audiotaped interviews were transcribed. With the assistance of NUD*IST (Qualitative Solutions and Research, 1997), transcriptions were analysed and coded. The results from the concept maps and the semi-structured interviews over the time of the project were combined and compared for analysis. Patterns in responses and changes in emphasis were also identified and coded for analysis.

Participants

All preservice teachers enrolled in the Master of Teaching Program (Primary) in 2000 (N=70) at the University of Sydney were invited to participate in the project. Twenty-two students volunteered to participate and of these 12 were randomly selected to form the cohort for the study.

The Master of Teaching Program is a post-graduate qualification. Students entering this program come from a wide variety of backgrounds. On the whole, the students are mature aged and have worked in some area other than teaching for a number of years before deciding to embark on a career in teaching. A major goal of the program is to produce teachers who are reflective practitioners. Furthermore, and as indicated earlier, the primary mathematics education courses are designed not only from a constructivist perspective, but from a situative perspective. Hence, students are encouraged to build and reflect on their existing mathematical beliefs and knowledge and trial new practices as they explore how children learn mathematics in multiple learning contexts.

Procedure

Initially, participants were asked to draw a concept map for the word 'mathematics' during their first mathematics methods workshop. Following this, each participant was individually interviewed. The major purpose of the semi-structured interview was to allow each participant an opportunity to explain and elaborate on their map. This procedure was undertaken a second time at the end of the second course in mathematics, approximately 16 weeks after their first concept map. Prior to the completion of the second concept mapping exercise and interview, student teachers undertook four 2 hour sessions assessing and teaching small groups of children in schools. This was done while under the direct supervision of their mathematics educator. In addition, the student teachers had completed 4 weeks of practice teaching.

Two more concept mapping and interview sessions are planned for subsequent phases of the study. Each one is planned to occur after the preservice teachers have completed components of their mathematics instruction that is situated in a least two different learning contexts. Namely, university-based workshops, 4 weeks of practice teaching, university-based teaching of children with special need in numeracy and a 10 week internship.

Results and Discussion

This section presents and discusses the findings derived from an analysis of the concept maps and interviews of all 12 student teachers. However, due to length restrictions discussion will mainly focus on one participant—Ann. Ann's concept maps have been included to assist with an explanation of the results and were selected on the basis that the characteristics of her maps seemed to typify those of the other participants.

Figure 1 shows Ann's first concept map. This map was drawn prior to any formal instruction in mathematics education. Her map reflects two characteristics that were common to the majority of participants' initial concept maps. The first included feelings or emotive reactions towards the subject (e.g. 'panic' and 'blackout') and the second included a view or conceptualisation of mathematics as a content driven subject (e.g. 'times table').

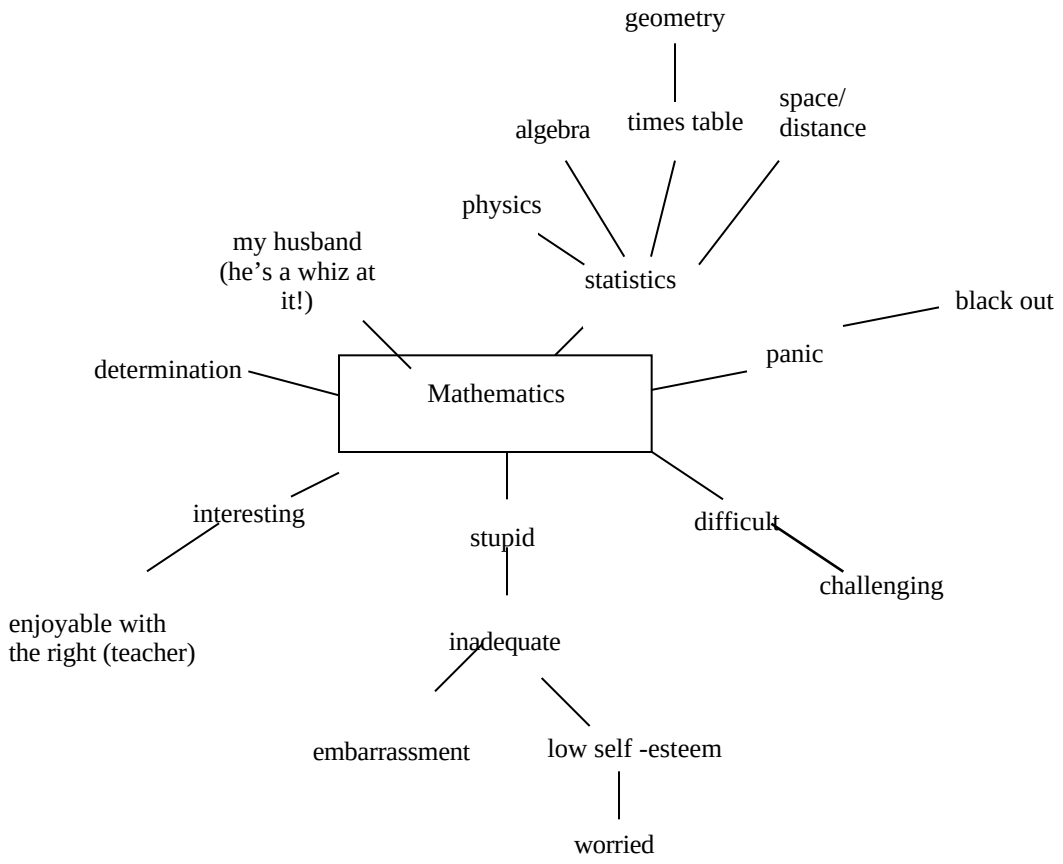

Figure 1. The first concept map constructed by Ann.

These two characteristics were identified as significant themes in the semi-structured interviews. Ten of the participants commented on feelings of "boredom" and "frustration" leading to a negative attitude to the subject. One student commented in the first interview that she "put down *fear* first" when she thought of mathematics.

The view of mathematics as content driven was reflected in comments that identified mathematics as "pure procedure". In addition, the traditional view of mathematics as

right/wrong answers, memorising formulae and rote learning procedures were commonly represented in participants' first concept maps.

While other themes emerged from the concept maps and interviews, it was these two areas that underwent the most significant change as a result of exposure to the first three contexts in which their mathematics instruction was situated. The three contexts being the university-based workshops, the classroom-based teaching of small groups under the direct supervision of their lecturer and a 4 week practicum. In relation to Ann, the strong negative feelings identified in the first interview and concept map were highlighted by Ann herself as an area of significant change when explaining her second concept map (see Figure 2).

This change in attitude was evident by comments she made about her second map during the interview: "It's a lot more positive in comparison to the one I wrote initially. I wrote things like panic, blackout, difficult, challenging, inadequate, stupid, low self-esteem and worried". She also spoke about a growth in her confidence. In the second interview she identified this change as an important factor influencing the way she would teach mathematics.

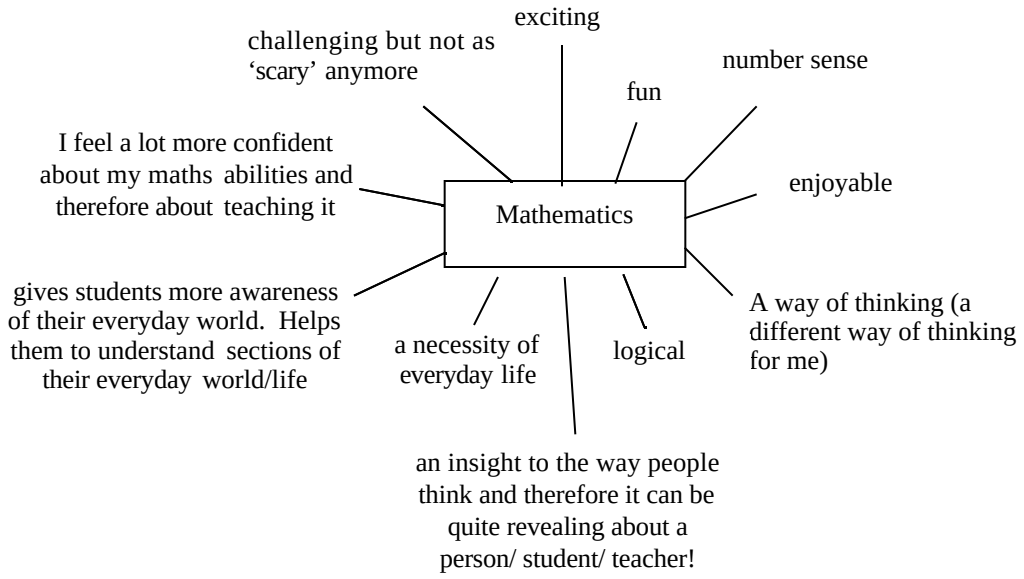

Figure 2. The second concept map constructed by Ann.

The second concept map and interview revealed that Ann's very notion of what mathematics was had undergone change. Whilst the first map focussed on the content-base of mathematics, the second map reflected a reconceptualisation of mathematics as "a way of thinking". Ann noted that the second concept map "..really demonstrated how I have changed my whole thinking about maths".

These changes to her feelings about and view of mathematics were reflected in her response to a question concerning changes in her pedagogical knowledge. Her comments focussed on "awareness of their everyday world". She felt strongly about the "need for knowledge to be built on". She used the term "building bricks" and felt that knowledge needed to be constructed initially from links to the child's world. She generalised this approach to incorporate all subjects "not just maths". Further, she made links to a previous

comment about "a way of thinking" when she discussed the teaching strategies she needed to use: "...you need to be aware of the different methods they used to get the answer...you need enough room for each child to be able to use their own way rather than trying to enforce one way of doing it".

While such changes in attitude and a reconceptualisation of mathematics were common to most participants, of more interest were the factors student teachers perceived to be responsible for inciting such changes. When reflecting on the reasons for the changes Ann had noted in her attitude, confidence and conception of mathematics, she considered "the training here, the whole way that we learn how to teach maths" was a significant factor. Ann believed that the structure of the mathematics courses she had experienced so far had prepared her well for teaching mathematics:

> Actually, on prac the thing that I was most confident about teaching was maths and at the beginning of this course I would never have said that because it was my worst topic and I was dreading teaching it…we are so well prepared for prac compared to all the other subjects…the lectures and the hands-on stuff…it really prepared me and geared me up and calmed me down.

Ann had developed a confidence to teach mathematics in a way that was different to how she had been taught and different to what was demonstrated to her during practice teaching experiences. This was evident when she described how the cooperating teacher on her practicum taught mathematics "every time with a textbook" and how she "actually pushed to teach maths" her way: "he watched my lesson and was interested in how I was doing it and the reaction of the kids…".

Conclusion

Thoughtfully situating preservice teachers' learning simultaneously in university and practically-based contexts is considered crucial to the success of mathematics methods courses for preservice teachers. Simply relying on preservice teachers to enact upon new insights into knowledge and beliefs during their normal practice teaching components is not a satisfactory alternative. This is especially true since the teaching approaches advocated at university may not be adhered to in the various practical settings available to preservice teachers and preservice teachers are unlikely to take 'risks' experimenting with new approaches when their teaching performance is being assessed.

The intention of the current study was to explore the impact of a mathematics teacher education course on the mathematical beliefs, knowledge, and practices on preservice primary teachers in an attempt to identify factors which might be more successful in inciting them to modify their beliefs and begin reconceptualising their views of mathematics. Preliminary findings indicate that the utilisation of a multiplicity of learning contexts may explain why our findings contradict those of previous studies in this area. However, at the time of writing this report, the preservice teachers had only been exposed to three of the five planned contexts in which their mathematics education course is situated. The next phase of the study will confirm initial comments by participants regarding the impact the various contexts for learning have had on their mathematical beliefs, knowledge and practices. In particular, it will focus on the extent to which this impact is translated into classroom practice during a ten week internship.

References

Australian Education Council. (1990). *A national statement on mathematics for Australian schools*. Canberra: Curriculum Corporation.

Beattie, M. (1997). Fostering reflective practice in teacher education: Inquiry as a framework for the construction of a professional knowledge in teaching. *Asia-Pacific Journal of Teacher Education*, 25, 111-128.

Bobis, J. (2000). *The impact of Count Me in Too on the professional knowledge of teachers.* Sydney: NSW Department of Education and Training.

Benbow, R. (1993).Tracing mathematical beliefs of preservice teachers through integrated content-methods courses. *Proceedings of the annual conference of the American Educational Research Association*. (ERIC document ED 388 638).

Brown, J., Collins, A., & Duguid, P.(1989). Situated cognition and the culture of learning. *Educational Researcher*, 18(1), 32-42.

Buzeika, A. (1996). Teachers' beliefs and practices: The chicken or the egg? In P. Clarkson (Ed.), *Technology in mathematics education* (Proceedings of the 19th annual conference of the Mathematics Education Research Group of Australasia). Melbourne: MERGA.

Department of Employment, Education & Training (1989). *Discipline review of teacher education in mathematics and science.* Canberra : Australian Government Printer.

Ernest, P.(2000). The impact of beliefs on the teaching of mathematics. *Square One.* 10(4), 12-14

Foss, D., & Kleinsasser, R. (1996). Preservice elementary teachers' views of pedagogical and mathematical content knowledge. *Teaching and Teacher Education*, 12, 429-442

Fuson, K., Carroll, W., & Drueck, J. (2000). Achievement results for second and third graders using the standards-based curriculum Everyday Mathematics. *Journal for Research in Mathematics Education, 3*, 277-295.

Greeno, J. (1997). On claims they answer the wrong question. *Educational Researcher.* 26(1), 5-17.

Jones, M., & Vesilind, E.. (1996). Putting practice into theory: changes in the organisation of preservice teachers' pedagogical knowledge. *American Educational Research Journal.* 33, 91-117.

Klein, M. (1999). The construction of agency in mathematics teacher education and development programs: A poststructuralist analysis, *Mathematics Teacher Education and Development.* 1, 84-93.

Laturno, J. (1994). The validity of concept maps as a research tool in remedial mathematics. In D. Kirshtner (Ed). *Proceedings of the sixteenth annual conference of the North American Chapter of the International Group for the Psychology of Mathematics Education* (Vol.2, 60-66). Baton Rouge: Louisana State University.

Novak, J., & Gowin, D. (1984) *Learning how to learn*. Cambridge, England: Cambridge University Press.

Putnam, R., & Borko, H. (2000). What do new views of knowledge and thinking have to say about research on teacher learning? *Educational Researcher.* 29(1). 4-15.

Ricardson, V. (1996). The role of attitudes and beliefs in learning to teach. In J. Sikula (Eds.), *The handbook of research in teacher education* (pp. 102-119). New York: Macmillan.

Qualitative Solutions and Research. (1997) *NUD*IST*. Melbourne: Latrobe University.

Trowbridge,J. &Wandersee,J. (1994). Identifying critical issues in learning in a college course on evolution. *Journal of Research in Science Teaching*, 31, 459-473.