

Affective Development in Mathematics: A Case Study of Two Preservice Primary School Teachers

Peter Grootenboer

Bethlehem Institute of Education

<p-grootenboer@bethlehem.ac.nz>

Preservice primary school teachers come to their initial teacher education programs with beliefs, attitudes, values and feelings about mathematics and mathematics education. These have been formed through their experiences of mathematics prior to tertiary study and they can powerfully impact on their development as a teacher of mathematics. Then, during their teacher education they have another set of experiences of mathematics, which further impact on their views and emotions about the discipline. This study focuses on two preservice primary teachers in the first year of their initial teacher education and through a series of interviews and tasks it explores their affective views towards mathematics. It seems from the study that tertiary mathematics education courses need to explicitly and continually revisit the preservice teachers' affective positions if positive development is to occur.

The beliefs, attitudes, values and feelings of preservice and inservice teachers towards mathematics have become a topic of increasing interest for mathematics educators as is evidenced by the growing number of articles and papers published in recent times. A growing awareness of the impact of affective factors combined with the realisation that many teachers have debilitating views of mathematics, mathematics teaching and learning is concerning. The literature includes a number of studies attempting to address the negative cycle of beliefs, attitudes and feelings preservice teachers bring to mathematics. Overall the results are inconclusive with some reporting limited positive change (eg., Aldridge & Bobis, 2001), some lamented little change (eg., Artzt, 1999) and few studies report success in reforming negative or debilitating views. McLeod (1992) notes in his comprehensive review of research in the area that "although affect is a central concern of students and teachers, research on affect in mathematics education continues to reside on the periphery of the field"(p. 575).

This paper reports an investigation of the affective positions of two preservice primary school teachers, particularly as they relate to their experiences of mathematics and mathematics education. Initially the study focussed on their experiences prior to commencing their tertiary teacher education. The second phase explored their experiences during their first semester in teacher education and in particular their development through their first course on the teaching of mathematics. Finally, the study explored their beliefs, attitudes and values after their practicum experience.

Literature Review

Teaching includes an affective dimension and a teacher's beliefs, attitudes, values and feelings impact on their classroom work (Hargreaves, 1998). A number of studies have researched facets of the affective domain in mathematics education, including: (1) beliefs about mathematics, mathematics teaching and learning (eg., Ball, 1990; Mayers, 1994; Schuck, 1997b); (2) values (eg., Clarkson, Bishop, FitzSimons & Seah, 2000); (3) attitudes (eg., Sullivan, 1987; Way & Relich, 1993); and (4) feelings (eg., Carroll, 1994; Kelly &

Tomhave, 1985). Perhaps the saddest aspect of these studies is the overwhelming sense that mathematics is perceived by many in negative and destructive ways. Carroll (1994, p. 131) noted that “many people seemed to be constrained by negative attitudes, beliefs and feelings about mathematics and mathematics learning”.

Teacher Beliefs and Attitudes

It is of concern that primary school teachers, not immune to these negative views of mathematics, teach mathematics and their views influence their mathematical pedagogy (Ball, 1990; Bobis & Cusworth, 1994; Schuck, 1997a, b; Sullivan, 1987). Thompson (1992) suggested that most teachers view mathematics in an absolutist or instrumental fashion. Further to this, Mayers (1994) found that teachers who held an absolutist or instrumental view tended to teach through exposition, practice and rote learning. This confirmation of the connection between a teacher’s affective views and practice was noted by Schuck (1996) when she stated; “... the work of primary school teachers in mathematics is generally seen to differ from their work in other subject areas; mathematics is transmitted...” (p. 119).

A number of studies have found that the absolutist and instrumentalist views of mathematics predominate amongst preservice primary school teachers and that these views block the development of mathematics as a human activity (Cooney, Shealy & Arvold, 1998; Mayers, 1994; Schuck, 1997a, b). Many preservice teachers have beliefs about mathematics and mathematics teaching that are narrow (Schuck, 1997b) enacting these through a transmission-model of teaching (Biddulph, 1992).

Often these narrow views about mathematics are accompanied by negative attitudes towards the subject. In a study with preservice primary teachers Grootenboer (2000) reported that almost 70 percent of the participants had a negative attitude to mathematics, and Biddulph (1999, p. 66) found that “... between one-half and two-thirds [of the primary teacher education students] had distinctly negative feelings about the subject”. Biddulph elaborated on the attitudes of this group: “The students in the negative category expressed feelings that ranged from lacking enthusiasm, to being nervous, scared, feeling a total failure and terrified, being totally intimidated and hating or loathing it” (p. 67). In a case study of one “mathsphobic” preservice teacher, Carroll (1994) observed that a lack of confidence and destructive feelings about mathematics made it difficult for the participant to learn basic mathematical ideas, let alone teach them in a meaningful way.

Experiences of Mathematics

Most preservice teachers’ experiences of mathematics have been in a classroom. Grootenboer (2001) reported that in his study many participants could recall in great detail their mathematics teachers even though they could not recall a great deal of the content knowledge they studied. Around two-thirds of the respondents described, with some emotion, disliked or unappreciated teachers. Furthermore, Carroll (1998, p. 1) contended that “often students’ attitudes became negative during secondary school”. It would seem then, that for many their experiences of mathematics have been unpleasant and negative, and through these experiences they have developed their attitudes and feelings towards the subject (Carroll, 1994; Grootenboer & Lowrie, 2002; McLeod, 1992).

Lortie (1975) developed the concept of an “apprenticeship of observation” to explain the learning of preservice teachers during their years of experiencing teaching first-hand as a school student. For mathematics education, Ball (1990) commented:

Prospective teachers are ... unlikely to acquire an appropriate view of the discipline as a result of precollege mathematics experience. The view they hold is likely to shape not only the way they teach mathematics once they begin teaching but also the way in which they approach *learning to teach* mathematics: A vicious cycle emerges. (p. 463)

If indeed there is a cycle linking school experience to affective development and teaching practice then the most likely point for an intervention to break it is within initial teacher education.

The Study

The research presented in this paper reports on the affective development of two preservice primary school teachers through the first year of their three-year teacher education programme. The first participant, Brad (pseudonym), came straight to teacher education from secondary school where he had been a successful sportsman and school leader. Marina (pseudonym), the second participant, was in her late twenties and she started her tertiary teacher education with a range of life experiences. The study focuses on their affective views in reference to their experiences: (1) as a school student; (2) during their first course in the teaching of mathematics; and (3) on practicum.

Theoretical Framework

In essence, the study was an exploration of the participants’ personal interface with mathematics and their perceptions of those experiences. The desire for a holistic, human methodology with an emphasis on experience and perception meant that a phenomenological framework was most appropriate (Cohen, Manion & Morrison, 2000). Such research is descriptive, emphasising experience as the object of inquiry and incorporating sense impressions, perception, feelings, beliefs and values as being significant (Creswell, 1998).

Methods

The qualitative study employed two modes of data collection. The first was interviewing and occurred in February, July and November 2001. The 60-minute interviews were semi-structured and at the time they were audiotaped and later transcribed by the researcher. Each interview focussed on a different phase of their experience with mathematics and mathematics education. The first interview was directed at school experience, the second toward tertiary experience within their course on the teaching of mathematics and the third focussed on related experiences during practicum. The second mode of data collection was a journal which the participants maintained throughout the study. At times certain questions and prompts from the lecturers in their introductory course on the teaching of mathematics guided the participants’ journal entries.

Data analysis utilized phenomenological techniques where initially the researcher must note and record any preconceptions about the topic of interest (Moustakas, 1994). The data were then read and re-read in order to gain a feel for the phenomenon. Coding was used to identify key themes across the descriptions using the *NUD*IST* computer program (Qualitative Solutions & Research, 1997), and then the overall descriptions of the

phenomenon were crafted (Creswell, 1998).

Findings

The experiences and associated affective responses of the participants were explored in relation to three particular contexts outlined previously. Although these particular experiences are unique, they do impact the experiences that they precede, therefore they will be discussed in chronological order. Where possible, the participants' own words are used to explicate and exemplify the findings.

Experiences as a School Student

Generally, the participants could remember little of their mathematics at primary school other than having quizzes and tests on their "times-tables". Marina recalled feeling "quite dumb in standard one" because she couldn't recite all her tables quickly, and her teacher had made her write them out several times during the lunch-break. In her first interview she said:

I know that knowing your times-tables is really important – probably one of the most important things you need to learn at primary school, but I'm still not too confident about my sevens and twelves. I think this is something I'm going to have to brush-up on if I am going to be a teacher!

Brad remembered playing with some "coloured sticks" (Cuisenaire rods) and his times-table tests every Friday. He suggested that the key to passing these tests was not to necessarily know the answers, but to sit next to someone who did and, when you could get away with it, mark your own test.

Both Brad and Marina could recall greater detail of their secondary school mathematics classes, and indeed both described in great detail some of their teachers. However, neither of them could recall a mathematics teacher they liked or respected, in fact they described their teachers as being sarcastic, disinterested and incompetent. Brad described his year ten mathematics teacher:

Mr Howard [pseudonym] was good at maths himself, but he couldn't relate to me. I was into sports and he wasn't, and he thought I just wasted all my time playing rugby and cricket when I should have been studying. When I failed a test or didn't get something he'd just say that I needed to do more work and spend less time chasing balls. ... I really hated him in the end and I just gave up.

He said that after his year with this teacher, he basically gave up on mathematics and didn't try to understand it until in his last year when he thought he needed to pass mathematics to get accepted into a teacher education programme.

In describing their mathematics classes, the experiences of the two participants sounded remarkably similar, regardless of year level, teacher or school. Below is part of one of Marina's descriptions she penned in her journal:

Class began with the teacher explaining stuff from the blackboard with heaps of notes for us to copy down. Then he would do two or three examples which we also copied down. At this point most of us were confused! We would be set some pages of work to do from the textbook, and after we ruled up our books properly we would do the exercises. Most of the time we'd copy the answers from the back of the book, although sometimes the teacher wanted to see some working. At the end of the lesson we'd get told to complete the exercises for homework.

Brad's experiences were almost identical, as were Marina's when she outlined her classes at different levels of her secondary schooling.

After their experiences of mathematics at school, both participants thought that mathematics was important, but neither of them knew why. Furthermore, they described mathematics as being mostly about numbers and “the basics”, irrelevant to life, mysterious and difficult for all but geniuses to understand. Marina added that she was also very anxious about having to do “mathematics courses” as part of her teacher education as she was a “maths dummy”. Brad also said that he was “mathematically challenged”, and he’d do it because “it was important for kids to learn maths” even though it was “largely irrelevant”.

Experiences in Their Tertiary Teaching of Mathematics Course

The students undertook a course in the teaching of mathematics during the first semester of their teacher education programme. This course involved two 90-minute sessions a week for twelve weeks and its rationale espoused a constructivist approach to teaching and learning mathematics. Their classes incorporated a range of activities including lectures, workshops, readings, role-plays, discussions and field trips. After the course, Marina commented:

I loved the course! I never thought I would have said that about a maths class! Maybe it is just because I am older and more focussed now, but I do enjoy maths and I can see it all around me everyday. ... Matt [pseudonym – one of the course lecturers] was really interesting and passionate about his stuff – maybe I have caught this love of maths off him! He spent time with me, explained things and challenged me to look at maths again. He even helped me with my times-tables!

Brad also wrote:

Yep, it was primo! I had a lot of fun and enjoyed the classes, which is a change. I thought the field trip was cool – it showed me that maths is useful and all around us. I can see that maths is more than just working from a textbook and blah, blah, blah from the blackboard. ...

They still thought that mathematics was important and that “all kids need to know the basics”, the basics being arithmetic, times-tables and fractions. However, both participants also emphasised the need to “understand mathematics rather than just being able to do it”, and that mathematics was relevant to life outside the classroom.

Experiences During Their School Practicum

Marina’s practicum was in a year three class in an innovative school which was involved in the Early Numeracy Project (ENP). Her associate teacher allowed Marina to have a small group of students for mathematics each day and she encouraged her to try out some of the ENP material. Marina said that “her teacher was a treasure who really loved the kids”, and in her mathematics teaching “Beryl [pseudonym] always tried to make learning fun and relevant – she was setting them up for success”. In reconciling her practicum experiences with her prior views Marina commented:

That stuff that we learned in lectures [in the mathematics education course] was spot-on. On the prac I could really see how kids can be switched onto maths – about teaching to their hearts as well as their heads! Kids can actually enjoy maths – amazing – I never thought it would be possible!

Clearly there was a sense of astonishment for Marina in seeing mathematics differently, although she later acknowledged:

It is still a struggle. If I don’t consciously think about it then I go back to my old ways and I become anxious and rigid. ... It’s like a bad habit of the brain, something I need to consciously and consistently work on or else I go back to thinking [about mathematics] how I did before.

For Brad, his practicum experience was quite different. His time was spent in a year seven class where they were streamed and they followed a “traditional mathematics program”. Brad described the mathematics classes he experienced:

Every lesson was the same. The teacher had a blue folder with all the worksheets for the unit, so after their pre-test the kids would chug their way through the worksheets one at a time until the end. After three weeks, the teacher gave them the test. The teacher had a few notes on the board at the start of each lesson which some of the kids copied down, but she never really taught them stuff from the front. ... It was boring man and I nearly fell asleep sometimes!

When asked to reflect upon his experiences he commented:

I think that stuff we learned with [the mathematics education course lecturer] was fun, but when it comes down to it, it doesn't work in real teaching. ... Kids can't do step 42 if they don't get step 41, and so you need to teach everything step by step. This is hard with 30 kids in the class but streaming definitely helps. ... The students have to know the basics.

Interestingly, although Brad expressed little enthusiasm for the mathematical pedagogy he experienced on his practicum, his views about mathematics and mathematics teaching seemed to be consistent with those of his associate teacher.

Discussion

While this study has only focussed on the experiences of two preservice primary school teachers, there appears to be some important features that have emerged. Firstly, the participants perceived their school mathematics as a negative experience, which caused them to develop feelings of anxiety and inadequacy. This finding is indeed sad and disappointing, particularly when it appears to be consistent with the majority of the literature (eg., Carroll, 1994; Grootenboer & Lowrie, 2002). Furthermore, their experiences were consistent with absolutist and instrumental views of mathematics as is evidenced by the emphasis they placed on times-tables and “the basics”. Even though Brad had been at school immediately prior to starting his initial teacher education and Marina had not been to school for at least twelve years, their school experiences were remarkably similar, and this was despite a major curriculum reform in between. Both of their experiences were characterised by teaching that was narrow and based on a transmission-model, which again is consistent with the findings of others (eg., Biddulph, 1992). These experiences had facilitated the development of Brad and Marina's affective views of mathematics, which they brought to their tertiary teacher education program.

It was heartening to note the changes in Marina and Brad's affective dispositions after their participation in their tertiary mathematics education course. This was probably a predictable outcome, and indeed one would be worried if such a course facilitated no growth in beliefs about mathematics, or change in attitude towards the subject. However, it was fascinating to note the continuing strong conviction and commitment to times-tables as being important. A number of other studies have reported reform in preservice teachers affective views through tertiary mathematics education courses, but perhaps what is more important is if these changes are significant enough to last into the teachers' inservice careers. The strength of the beliefs, attitudes and feelings that preservice teachers develop as school students during their “apprenticeship of observation” render any long-term effect from their tertiary courses problematic (Richardson, 1996). Indeed, there is scope for longitudinal research to explore the long-term impact of tertiary mathematics education

courses. The current study did however, follow the preservice teachers through one post-course experience, namely the school practicum.

The participants' experiences had been similar in many respects up to this point, but during their school placements they encountered mathematics education in different ways. For Brad and Marina, their experiences were significant events in their affective development and they indicate the power of the practicum placement to confirm or deny the learning of the tertiary course. This has been noted by a number of authors who have expressed concern over the possible miseducative nature of school practicums (eg., Calderhead, 1988). Clearly for Brad this was the case as his experiences were confirming of his views prior to entering his initial teacher education program. Perhaps it was because his practicum experiences matched up with his own school experiences, that this reality was too strong for him to conceive of mathematics, mathematics teaching and learning in other ways. For Marina however, her practicum experiences continued to support her new perspective of mathematics and she was able to continue her affective growth in more positive and healthy ways. Interestingly, she was still able to note the struggle she had as she fought against her previous views that she described as her "default mode".

Although this study was only small, the weight of the literature in general means that mathematics educators need to accept, at least at present, that many preservice teachers are going to start their initial teacher education with poor and/or negative views of mathematics. Given that, a fundamental concern of their mathematics education courses needs to be affective reform, otherwise teachers will begin their teaching careers with beliefs, values, attitudes and feelings towards mathematics that hinder positive and effective mathematics teaching and learning. Furthermore, there needs to be some thought given to how preservice teachers' views about mathematics and mathematics teaching develop through their practicum experience, and how these can be reviewed if their mathematics education coursework is over. Finally, there is a great need for some longitudinal research into the long-term changes and developments in teachers' affective views towards mathematics as they progress through their teaching careers.

References

- Aldridge, S., & Bobis, J. (2001). Multiple learning contexts: A vehicle for changing preservice primary teachers' mathematical beliefs, knowledge and practices. In J. Bobis, B. Perry, & M. Mitchelmore (Eds.), *Numeracy and beyond* (Proceedings of the twenty-fourth annual conference of the Mathematics Education Research Group of Australasia, pp. 43-49). Sydney: MERGA.
- Artzt, A. F. (1999). A structure to enable preservice teachers of mathematics to reflect on their teaching. *Journal of Mathematics Teacher Education*, 2, 143-166.
- Ball, D. L. (1990). The mathematical understandings that prospective teachers bring to teacher education. *The Elementary School Journal*, 90(4), 449-466.
- Biddulph, F. (1992). Challenging primary student teachers' views about mathematics education. In B. Southwell, B. Perry, & K. Owens (Eds.), *Space – The first and final frontier*. (Proceedings of the fifteenth annual conference of the Mathematics Education Research Group of Australasia, pp. 128-136). Sydney: MERGA.
- Biddulph, F. (1999). The legacy of schooling: Student teachers' initial mathematical feelings and competence. *Mathematics Teacher Education and Development*, 1, 64-71.
- Bobis, J., & Cusworth, R. (1994). Teacher education: A watershed for preservice teachers' attitudes towards mathematics. In G. Bell, B. Wright, N. Leeson & J. Geake (Eds.), *Challenges in mathematics education: Constraints and construction* (Proceedings of the seventeenth annual conference of the Mathematics Education Research Group of Australasia, pp. 419-428). Lismore, NSW: MERGA.
- Calderhead, J. (Ed.). (1988). *Teachers' professional learning*. London: The Falmer Press.

- Carroll, J. (1994). What makes a person mathsphobic? A case study investigating affective, cognitive and social aspects of a trainee teacher's mathematical understanding and thinking. *Mathematics Education Research Journal*, 6(2), 131-143.
- Carroll, J. (1998, December). *Understanding professional development through the analysis of the mathematical life histories of primary school teachers*. Paper presented at the annual conference of the Australian Association for Research in Education, Adelaide.
- Clarkson, P. C., Bishop, A. J., FitzSimons, G. E., & Seah, W. T. (2000). Challenges and constraints in researching values. In J. Bana & A. Chapman (Eds.), *Mathematics education beyond 2000* (Proceedings of the twenty-third annual conference of the Mathematics Education Research Group of Australasia, pp. 188-195). Fremantle, Australia: MERGA.
- Cohen, L., Manion, L., & Morrison, K. (2000). *Research methods in education* (5th ed.). London: Routledge.
- Cooney, T., Shealy, B., & Arvold, B. (1998). Conceptualizing belief structures of preservice secondary mathematics teachers. *Journal for Research in Mathematics Education*, 29(3), 306-333.
- Creswell, J. (1998). *Qualitative inquiry and research design: Choosing among five traditions*. Thousand Oaks, CA: Sage.
- Grootenboer, P. J. (2000). Preservice primary schoolteachers' perceptions of their experiences of school mathematics. *Journal of Educational Inquiry*, 1. Retrieved September 8, 2000 from the World Wide Web: http://www.soe.waikato.ac.nz/Journal/Math_Experience.htm
- Grootenboer, P. J. (2001, July). *Preservice primary school teachers' perceptions of their mathematics teachers*. Paper presented at the annual conference of the Mathematics Education Research Group of Australasia, Sydney.
- Grootenboer, P. J., & Lowrie, T. (2002). *Preservice primary school teachers' views on mathematics and mathematics teaching*. Paper accepted to be presented at the South East Asian Regional Conference on Mathematics Education, Singapore, May.
- Hargreaves, A. (1998). The emotional practice of teaching. *Teaching and Teacher Education*, 14(8), 835-854.
- Kelly, W. P., & Tomhave, W. K. (1985). A study of math anxiety/math avoidance in preservice elementary teachers. *Arithmetic Teacher*, 32(5), 51-53.
- Lortie, D. (1975). *Schoolteacher: A sociological study*. Chicago, IL: The University of Chicago Press.
- Mayers, C. (1994). Mathematics and mathematics teaching: Changes in pre-service student-teachers' beliefs and values. In G. Bell, B. Wright, N. Leeson, & J. Geake (Eds.), *Challenges in mathematics education: Constraints and construction* (Proceedings of the seventeenth annual conference of the Mathematics Education Research Group of Australasia, pp. 419-428). Lismore, NSW: MERGA.
- McLeod, D. B. (1992). Research on affect in mathematics education: A reconceptualization. In D. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 575-596). New York, NY: Macmillan.
- Moustakas, C. (1994). *Phenomenological research methods*. Thousand Oaks, CA: Sage.
- Qualitative Solutions & Research (1997). *NUD*IST* [Computer software]. Melbourne: Author.
- Richardson, V. (1996). The role of attitudes and beliefs in learning to teach. In J. Sikula (Ed.), *Handbook of research on teacher education* (2nd ed.) (pp. 102-119). New York: Association of Teacher Educators.
- Schuck, S. (1996). Chains in primary teacher mathematics education courses: An analysis of powerful constraints. *Mathematics Education Research Journal*, 8(2), 119-136.
- Schuck, S. (1997a). Using a research simulation to challenge prospective teachers' beliefs about mathematics. *Teaching and Teacher Education*, 13(5), 529-539.
- Schuck, S. (1997b). The three selves of the prospective primary school teacher of mathematics: An Australian case study. In F. Biddulph & K. Carr (Eds.), *People in Mathematics Education* (Proceedings of the twentieth annual conference of the Mathematics Education Research Group of Australasia, pp. 443-449), Rotorua: MERGA.
- Sullivan, P. (1987) The impact of pre-service mathematics education on beginning primary teachers, *Research in Mathematics Education in Australia*, August, 1-9.
- Thompson, A. G. (1992). Teachers' beliefs and conceptions: A synthesis of the research. In D. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 127-146). New York, NY: Macmillan.
- Way, J., & Relich, J. (1993). Development of positive attitudes to mathematics: The perspective of pre-service teachers. In B. Atweh, C. Kanen, M. Carss, & G. Booker (Eds.), *Contexts in mathematics education* (Proceedings of the sixteenth annual conference of the Mathematics Education Research Group of Australasia, pp. 581-586). Brisbane, Australia: MERGA.