

The Impact of the School-based Practicum on Pre-service Teachers' Affective Development in Mathematics

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An integral part of all initial teacher education programs is the school-based practicum where pre-service teachers get an opportunity to develop their teaching skills and knowledge in a classroom setting. Many have suggested that these experiences are very powerful in shaping pre-service teachers' views of teaching because they are perceived as being 'real' as opposed to the 'artificial' environment of the tertiary courses. This can mean that the practicum experiences can legitimate or negate the learning of the tertiary courses. In particular, pre-service teachers can make significant positive changes in their affective responses to mathematics, but the longevity and stability of these changes can be challenged through their school-based practicum experiences.

In recent times there seems to have been considerable interest in students' and adults' affective responses to mathematics (Anthony, 2004; Leder & Grootenboer, 2005; Schuck & Grootenboer, 2004). In particular, a number of studies have explored pre-service primary teachers' affective responses towards mathematics (e.g., Aldridge & Bobis, 2001; Szydlik, Szydlik & Benson, 2003). These studies have generally indicated that many pre-service primary school teachers are not positively disposed towards mathematics and they are often fearful or resentful of the subject (Biddulph, 1999). Furthermore, many have suggested that pre-service teachers hold beliefs about mathematics that are debilitating and narrow (Ball, 1990; Szydlik et al., 2003). However, there have been some reports that indicate that it is possible to challenge and change the affective views of this group through tertiary courses in mathematics education (e.g., Aldridge & Bobis, 2001; Grootenboer, 2003). While this is a positive finding, it does not account for the broader context of the pre-service teachers' teacher education program. In this paper, the focus will be on the influence of the school-based practicum, which is an integral part of any initial teacher education. Data will be drawn from a study that explored the affective development of 29 pre-service primary teachers in mathematics over the first year of their initial teacher education program¹.

The School-Based Practicum

A significant aspect of teacher education programs is the school experience, often referred to as teaching practice, practicum, or student teaching. However, over twenty years ago Zeichner and Tabachnick (1981) questioned whether "the effects of university teacher education were 'washed out' by school experience" (p. 7). Practicum has the power of experience to critically shape the student teacher's perceptions of teaching and learning (Gustafson & Rowell, 1995).

Clearly, practice in schools provides experiences that cannot be replicated in the tertiary classroom, but Samaras and Gismondi (1998) noted that “the practicum has been viewed as an unmediated and unstructured apprenticeship which lacks course work and adequate supervision” (p. 716). Unless structures are in place to promote reflection and evaluation, the practicum can become an experience of uncritical practice that can work against quality teacher education (Burant & Kirby, 2002; Moore, 2003).

As students of the practice of teaching, pre-service teachers on practicum are observing and participating in the activities and rituals of teachers in the field as they participate in the authentic activity of teaching. They become involved in the wider aspects of the teaching community through meetings and staffroom discussions, appropriating the required dress codes, norms of behaviour, beliefs, values and attitudes of those in the profession. As such, they are appropriating the existing culture of the teachers in that particular school (Kagan, 1992). Samaras and Gismondi (1998) noted that:

... the newcomers’ legitimate peripherality provides them with more than an observational lookout post: It crucially involves participation as a way of learning – of both absorbing and being absorbed in – the culture of practice ... with opportunities to make the culture [of teaching] theirs. It is our belief that neophytes’ knowing about teaching develops not only through membership in a community, but through their interest in becoming agents of its activity. (p. 720)

Archer (1999) suggested that novice mathematics teachers tended to adopt and/or assimilate the beliefs and practices of senior colleagues. These practices are often grounded in a view that mathematics is about memorisation and rote learning of mathematical facts (Frykholm, 1998). As such, the practicum is often a major influence on the affective development of pre-service teachers (Gustafson & Rowell, 1995; Zevenbergen, 2005). In an overview of the professional growth of pre-service teachers, Kagan (1992) was critical of the idiosyncratic and unstructured nature of the school experience. Kagan (1992), Mewborn (1999), and Nesbitt Vacc and Bright (1999) all promoted the need for pre-service teachers to reflect critically upon their school experiences, and in particular the beliefs and values of both themselves and their associates in the school setting. Often the practicum experiences are similar to their own school experiences, thus reinforcing the beliefs and practices they developed as school students. In this regard they see the practicum as a real experience of mathematics teaching and learning and can discount the tertiary course-work experiences (Richardson, 1996). As opposed to the usual practicum experiences outlined above, Hill (2000) suggested that pre-service teachers need plenty of meaningful teaching practice if they are to be encouraged to relinquish their familiar beliefs and attitudes in favour of new views and dispositions of mathematics teaching and learning:

For meaningful and lasting change in attitudes and practices to occur in mathematics education, students must practice teaching mathematics for relational understanding, experience the responses of children to their teaching

approaches, and discuss and reflect on these experiences. The cycle must be repeated over a substantial period, allowing time for students to become familiar with the new ideas. (p. 29)

This is important in the teaching of mathematics given the apparent perpetual negative cycle of beliefs and values towards mathematics (Ball, 1990). Through reflective processes, pre-service teachers can become aware of their own beliefs, values, attitudes and feelings, and therefore be more deliberate in their affective growth (Hill, 2000; Mewborn, 1999).

The Study

The findings reported in this article emerged from a study conducted in New Zealand that explored the affective responses and changes of 29 pre-service primary school teachers (24 female, 5 male) in mathematics over the first year of their initial teacher education (ITE) program. There were 42 students altogether in the cohort and all were invited to participate with 31 accepting (two subsequently left the program leaving 29 participants). The participants' ITE program was three years in duration and included two courses on the learning and teaching of mathematics in their first and second years (for more details of the courses see Grootenboer, 2003). Each year of their program the participants were also involved in between six and eleven weeks of school-based practicum where they were placed with an experienced teacher in a classroom and given various teaching experiences commensurate with their progress through their ITE.

Data Collection

Cresswell (1997) suggested that a mixed-method approach is useful when trying to monitor and describe a phenomenon, so both qualitative (interviews, writing) and quantitative (questionnaire) methods were employed. Data were collected at three specific times relating to the pre-service teachers' mathematical experiences: (1) at school and prior to commencing their initial teacher education program; (2) during the first year tertiary course on the learning and teaching of mathematics; and (3) during their school-based practicum. The participants were also subsequently shown some of the general trends of the data in a graphical form and asked to respond.

At each of the three data collection times the participants were interviewed in small groups of between two and five people where they were asked to recount and describe their mathematical experiences during the corresponding period. The interviews were semi-structured, lasting between 25 and 70 minutes, and they were characterised by genuine and spontaneous discussion where the participants would talk with, and respond to, one another, not just to the prompts of the interviewer. At times the participants became quite emotional as they would recount unpleasant or distressing experiences, and often they could relate to the feelings of the others and they would empathise and comfort each other when required.

The quantitative data were collected through a questionnaire containing 25 items that required a response on a seven-point Likert scale (see Appendix A).

The questionnaire was administered at each of the three phases of the study. The prompts for the questionnaire were developed after reviewing a number of studies that had employed Likert-scale questionnaires to research the affective domain in mathematics education (e.g., Biddulph, 1999; Nisbet & Warren, 2000). The questionnaire focussed on the participants' affective responses to mathematics and included prompts that addressed the participants' beliefs (e.g., Mathematics is a creative and dynamic activity), attitudes (e.g., I have a positive attitude to mathematics), and feelings (e.g., I feel anxious about mathematics) about mathematics.

Findings – Quantitative Data

In this section the general changes in the participants' affective responses will be outlined before focussing more specifically on the apparent impact of the class year-level of the school-based practicum. Initially aspects of the quantitative data will be presented to highlight some of the changes in the participants' affective responses to mathematics over the study, and then these will be explored in the ensuing section through examples from the qualitative data that particularly relate to the practicum experience.

Changes in the Participants' Affective Responses over the Study

The questionnaire was employed on three occasions to explore any changes in the participants' affective responses to mathematics over the duration of the study. The Likert-scales were structured so that a lower score indicated a more positive affective response to mathematics (although this may appear counter-intuitive). A one-way repeated measures ANOVA was conducted to compare scores on the questionnaire at Time 1 (relating to their school experiences), Time 2 (following their experiences in the course *The Teaching of Mathematics 1*) and Time 3 (following their school-based practicum). The means and standard deviations are presented in Table 1. There was a significant effect for time, Wilks' Lambda = 0.421, $F(2, 27) = 18.56$, $p < 0.001$, multivariate eta squared = 0.58.

Table 1

Descriptive Statistics for the Questionnaire for Time 1, Time 2 and Time 3

Administrations of the Questionnaire	N	Mean	Standard Deviation
Time 1 (relating to their school experiences)	29	95.76	24.55
Time 2 (following their experiences in the course <i>The Teaching of Mathematics 1</i>)	29	67.17	14.43
Time 3 (following their school-based practicum)	29	79.24	20.14

The data indicated statistically significant changes in the participants' affective responses to mathematics over the period of the study. The ANOVA analysis identified a significant change in the participants' scores on the questionnaire over the three administrations of the questionnaire. In particular, the participants' responses were significantly more positive after their tertiary course on the teaching of mathematics than they were when the participants considered their school experiences as a pupil. However, their responses were more negative after their school-based practicum experience than they were after the course, but not as negative as they had been initially.

The Impact of the Year-Level of the Practicum

While the data outlined above indicate a clear pattern concerning the overall affective responses to mathematics of the group, the aggregation of their questionnaire scores does disguise some features. In New Zealand, generally school children spend Years 0 to 6 in a primary school and then Years 7 and 8 in an intermediate school before progressing to their secondary schooling. Initial primary teacher education programs prepare pre-service teachers to work in primary and intermediate schools. After the broad statistical analysis of the data reported above, the data were partitioned into two groups based on the type of school where the participants had their practicum (i.e., primary or intermediate). While the size of the sample does not lend itself to rigorous statistical analysis, the general descriptive statistics (Table 2) do reveal some interesting features about the influence of the practicum experience.

Table 2
Mean and Standard Deviation of the Group Scores

Type of Practicum School	N	Time 2	Time 3
Primary (Years 0-6)	20	M = 65.7 SD = 11.2	M = 72.0 SD = 15.1
Intermediate (Years 7-8)	9	M = 71.1 SD = 21.2	M = 98.3 SD = 19.9

The mean questionnaire score for the group who went to a primary school for their practicum changed by 6.3 (10%) indicating a slight regression in their affective views of mathematics, but the group who went to an intermediate school changed by 27.2 (38%), signifying a major shift in their views towards their initial largely negative position. In the next section this issue is explored through the qualitative data.

Findings – Qualitative Data

In this section the participants' affective responses to mathematics are explored and illustrated through the qualitative data from the study. The participants undertook a school-based practicum experience in a primary (Year 0 to 6) or intermediate (Year 7 to 8) school classroom during the second semester of the first year of their initial teacher education program. The data for this section were collected through interviews conducted after they had returned to their lecture program at their tertiary institution (i.e., Time 3). Almost all the participants reported experiences that were either positive or negative (with very few feeling "neutral"), and so the data are organised into two parts corresponding to these perspectives. As much as possible, the participants' words are used to illustrate their views.

Positive Mathematical Experiences during Practicum

Just over 40% of the participants returned from their school-based practicum and expressed positive reports of the mathematics they experienced. Positive participants were all in Year 0 to Year 5 classes (i.e., none were in a Year 6 to Year 8 class). These experiences were centred around the mathematics lessons they saw and taught with their placement classes. These participants noted a number of features of these lessons including a "hands-on" approach, working outside the classroom, variety, a thematic approach, and the use of mathematical games. Furthermore, some of these participants (6) also reported that the children in their classes seemed to be enthusiastic about mathematics and their mathematics lessons. Marina's² comment typified the views of mathematics that these participants expressed:

I thought the kids were really into it. One girl had completed her whole maths project [about preparing for their class camp] in one week! ... I think it was because it was meaningful, they could see maths was needed for life because they obviously needed it for their camp. (Marina, Year 3)

For the participants who enjoyed their mathematical experiences during their practicum, mathematics was described as being "meaningful", "connected", "creative", and involving "problem-solving" and "thinking strategies". The views they expressed about mathematics seemed to be closely related to the mathematics curriculum they encountered in the classroom with their associate teacher:

The maths we did in class was real and meaningful in normal life. [The associate teacher] linked maths with other stuff we were doing. (Janine, Year 2)

The kids really had to think, problem-solving and all those thinking strategies in the numeracy project. Maths was a whole new experience for me, a completely new subject. I loved it. (Nerolie, Year 4)

What appeared to be the key for these participants was the consistency they perceived between the epistemological messages of their course on mathematics education and their practicum experiences.

The cumulative effect of their tertiary mathematics education course and their practicum was acknowledged by eight of the participants in their interviews. They suggested that their experiences on practicum reinforced their affective and cognitive learning from the course. Karen's practicum was in a Year 5 class where she was given a small group of so-called slower children for mathematics. Her comments are linked together below to give a picture of her experiences:

From the first day we did a pre-test for fractions, decimals and place value. From then I was straight into teaching a group of six children to cover the work of the pre-test. I was given the 'dumb' [sic] ones, and not all of them said it but some did say they were useless at maths and they had never done well in maths ever.

I took the group and taught them how I wanted to teach them. We started with cutting cakes up for fractions, games and also calculator work.

We did a lesson outside of the classroom working with water. We had a coke bottle that was like a fuel tank and a pilot who kept running out of petrol and didn't know why because he couldn't read how much petrol was in the tank and so their job was to put little fractions on his tank so he could tell. It was a problem-solving activity and the children had to find the fractions of the fuel tank using water. It was quite hands on and the children loved the work.

My group of children went up 20 to 56 marks from their original pre-test even though I taught them a different way from their normal maths lessons, so it certainly doesn't harm them.

They were more confident when we went out and would come back. They were confident in answering questions and the teacher was quite surprised because they were not usually very confident in maths.

I found the work we did on the course really useful in helping me teach maths. All my maths learning was textbook based and so I thought that maths was largely irrelevant and unrelated to anything, you just regurgitated stuff. The course really showed me how you could see maths differently and it really worked with the group of students I had. (Karen, Year 5)

While it seemed that Karen's associate teacher conducted a fairly traditional mathematics program in her class, Karen was able to experiment with alternative pedagogical practices that were consistent with her tertiary mathematics education course. Because the teaching she employed seemed to be effective, the cumulative impact of the course and the practicum resulted in positive affective change for Karen. Unfortunately, more than half of the participants did not have such a positive experience of mathematics during their practicum and their data are now presented.

Negative Mathematical Experiences during Practicum

For nearly 50 percent of the participants their experiences of mathematics during their school-based practicum were not considered good or positive. The majority of these participants had their practicum in a Year 5 to Year 8 class with most (9

of the 15) in intermediate schools. One exception was Jaimee who was in a Year 1 class, and she reported:

I was in a Year 1 class and I think we did no more than four 20-minute lessons in the four weeks I was there. When I first got there we had agriculture day coming up so everything had to revolve around that, but then we didn't really get into the maths again. We did two addition lessons and two symmetry lessons. ... The kids did do some other maths because when they were naughty they didn't write lines or anything; they had to do maths for punishment. (Jaimee, Year 1)

Indeed there are some concerns about Jaimee's experience and the limited amount of mathematics over the four weeks, but it was not typical of those who reported a negative perception of their practicum mathematics.

As mentioned above, the participants who reported negative experiences were largely with older children, and the mathematics was described as content-focused, routine, worksheet or textbook-based, individualistic, and lacking in variety. Most of the reports were of streamed classes (ability grouped) which followed a "pre-test, teaching, post-test" unit pattern, and an :explanation, examples, worksheet or textbook" routine for the lessons:

Every lesson was the same, except when we were having a test. The kids would arrive from their classes [because they were streamed] and [the teacher] would talk for about 15 to 20 minutes, then he'd do two or three examples on the board, ask if there were any questions, and there never were, and then exercises for the rest of the lesson. Finish the exercises for homework. (Kylie, Year 7)

After his practicum experiences Warren commented on routines in learning mathematics:

There was a structure to the maths class timetable because as soon as you changed anything the kids became really unsettled. I taught one lesson slightly differently from how the teacher always does it and boy the kids let me know. They like the routine of maths and you'd be crazy to change it (Warren, Year 8).

While other participants in this group did not state it as clearly as Warren, there was a sense that mathematics was in fact routine, and learning mathematics was also best achieved through a fairly predictable lesson pattern.

Related to their experiences of mathematics and mathematics education being routine were reports of the subject as being infallible and disconnected from "real-life". Again, some of the participants expressed a view that this was a legitimate perspective on mathematics:

The maths classes were about learning their basic facts. ... The students spent all their time perfecting their maths skills and knowledge. ... We did one lesson on problem-solving but the kids didn't like it because they knew the basics is the really important stuff. (Darlene, Year 6)

Some of the participants (11 of the 15) in this group commented on the affective responses of their students to the mathematics curriculum they experienced and

the overwhelmingly common description was boring. While they could see and understand that many of the students in the mathematics classes were bored, they seemed to be resigned to the view that indeed mathematics is boring and this has to be accepted:

The kids were mostly bored, probably because the lessons were always the same. But it is maths and you can't change the subject, can you? (Helen, Year 6)

An underlying theme of the data from this group was that mathematics is routine, dull, infallible and unchanging, and the experiences they had on their tertiary mathematics education course were interesting, but largely irrelevant, at least in the school context.

Discussion

The quantitative and the qualitative data both indicated that the school-based practicum was a critical experience in the participants' mathematical affective development. While the participants seemed fairly homogeneous in their views at the end of their tertiary course in mathematics education, they appeared divided in the data collected during the third phase, as was indicated in Table 2. This seemed to show the profound influence that their school-based practicum had to either reinforce or undermine the new perspective of mathematics that they had developed through their tertiary course in mathematics education.

Affirming Positive Affective Change

The participants who had mathematical experiences during their practicum that they regarded as good, generally continued to hold positive affective views about mathematics. It seemed that the practicum experiences confirmed the affective changes that arose during their course, and therefore they became more assured in their new views. The consistency between the reality of the practicum experiences and the views and knowledge developed through their course appeared to be necessary for positive mathematical affective development in the participants.

In describing their experiences, the participants noted aspects of mathematics that were consistent with dimensions of Ernest's (1989) instrumental and problem-solving views. Again, these seemed to resonate with their mathematical encounters in the course and the repeated, consistent experiences in two different contexts led to more resilient affective views. Green (1971) suggested that primary beliefs develop through direct experience, and so it seems to have been important that these two realms of experience have coalesced towards a consistent mathematical epistemology that is more desirable. However, the sum of experience from the course and the practicum seems rather insignificant compared to the wealth of experience the participants brought with them from their own schooling. While it is positive that these participants have sustained their new perspective of mathematics through their practicum experience, it is still of concern as to whether it will be maintained

long-term. Indeed there is scope for longitudinal research to monitor the changes in pre-service teachers' affective views as they progress through pre-service and in-service teacher education. The relative instability of participants' views was particularly evident for those who perceived their mathematical experiences on practicum as negative.

The 'Washing-Out' of Affective Change

For approximately half of the participants, the mathematical experiences on their school-based practicum were viewed in a less than positive light. Interestingly, almost all of these participants were placed in senior primary or intermediate classrooms. In many respects, the experiences of these participants were similar to their recollections of their own schooling and as such it seemed to reinforce some of their beliefs and attitudes that they had prior to commencing their initial teacher education program. Perhaps the "real world" experiences in their own schooling and on practicum caused the participants to doubt the idealistic views that were developed in the artificial environment of the tertiary course. Indeed, in many respects it seems that their practicum experience did "wash-out" (Zeichner & Tabachnick, 1981) aspects of their affective development, particularly as it affirmed the views they held prior to their tertiary course in mathematics education.

The participants who perceived the practicum experience as negative often worked with classes that were streamed (ability grouped) and taught in a routine fashion. This caused Warren in his interview to comment that mathematics was indeed routine in nature and to conclude that students liked its "routineness". Also, Sally stated that mathematics is basically boring, and while it could be made more tasteful and interesting in the idealistic context of the tertiary course, the truth about mathematics is that it is dull and only accessible and enjoyable for "socially inept individuals". These participants illustrated how the practicum experience seems to have reinforced the beliefs and feelings they developed through their own mathematical education at school and, by implication, the insignificant influence of the tertiary course in mathematics teaching and learning (Frykholm, 1998).

Affective Development during Practicum

As the participants undertook their school based practicum they were engaged in many of the tasks and experiences that were closely associated with their chosen career. Indeed, the data revealed that there were a number who saw their time on practicum as "real life", as opposed to the tertiary course which was seen by a few as somewhat artificial. It seemed as if the participants saw their time in the school classroom as a form of apprenticeship where they could participate in the legitimate activities of a teacher and learn "what teaching was really about". As such, the pre-service teachers were involved in a form of "legitimate peripheral participation" (Lave & Wenger, 1991).

Through their classroom experiences the participants were, in a sense, being enculturated into the community of teachers (Lave & Wenger, 1991). This process involved learning the values, beliefs and attitudes of the community that were often not spoken, but woven into the fabric of teaching experience in a classroom. When it came to their experiences of mathematics teaching and learning, if these affective qualities supported the ones of their tertiary course, then their beliefs and attitudes were largely confirmed. However, when the underpinning values of their practicum experience were more akin to their own school experiences, then the affective development of the tertiary course was often negated. It seemed that the authentic activities of classroom practice conveyed the affective views that were perceived as legitimate, and to this end, the pre-service teachers were continuing their socialisation into the community of teaching practitioners (Jones, Brown, Hanley, & McNamara, 1999). This seems to highlight the inadequacy of trying to address affective issues in mathematics education through pre-service teacher education alone. This problematic issue requires research and development with both pre-service and in-service teachers, and the community at large.

Long-Term Changes in Affective Views

The influence of the school-based practicum to either reinforce or undermine the learning that occurs within a tertiary mathematics education course indicates the fragility of the participants' affective change post-schooling³. This study focussed on the first year of the participants' initial teacher education program, providing a snapshot of their affective responses to mathematics and mathematics education, providing insight into the contextual factors that influence affective development. It seems that for many of the participants, the positive changes in their affective views about mathematics are somewhat tenuous, and experiences either inside or beyond their tertiary program can quickly facilitate a return to their initial, primary beliefs formed through their own schooling.

In earlier discussion, it was suggested that tertiary teacher education courses in mathematics teaching and learning may be the key site to effect positive affective change, and indeed the data suggested that this may be the case. The difference between the tertiary course and the other influencing experiences (like their own schooling and practicum) is that it is largely directed by the mathematics educators concerned whereas the other experiences may be rather arbitrary. However, the experiences during their own schooling and during practicum have the perceived authority of being 'real-world', and hence, the experiences of the tertiary course could be dismissed as being idealistic and largely irrelevant. Certainly the participants will have another course in mathematics education, but they will also have further school-based practicums and eventually they will work in a school environment, and so it is sobering to consider that perhaps the cycle of negative affective views (Ball, 1990) will continue. It seems imperative that mathematics educators consider how they can work alongside pre-service teachers on or after practicum to help them reflect

upon their unmediated mathematical experiences and discuss their developing affective views. Furthermore, this reflection needs to be critical and focussed on the development of praxis through the consideration of theory and practice as symbiotically related (Kemmis, personal communication).

Conclusions

The finding that the participants' views after their school-based practicum reverted to initial views indicates two important points. The first is the tenuous nature of the affective reform achieved through the course experiences. The views about mathematics of half of the participants reverted back towards their primary beliefs, attitudes and feelings that they established through their own schooling, indicating that the gains of the course were not resilient enough in the context of an experience that reinforced their prior views. It seems likely that most of the participants will have at least some experiences through the remainder of their initial teacher education program that will reflect their own mathematical experiences at school and so it may be difficult for them to sustain their newly developed, healthier views of mathematics. The second point relates to the power of the school-based practicum to reinforce or undermine their course experiences. It seems that the practicum has the perceived power of being a real experience and hence relegates the experiences and learning of the tertiary course to being interesting but not applicable to the real world. These points, and others highlighted in this section, have implications for teacher educators, mathematicians and teachers, and these are now addressed.

While the initial changes of pre-service teachers' mathematical views seem to be important and to some degree achievable, the more apparent issue is the sustaining of those positive changes. The study clearly showed that experiences like the school-based practicum can "wash-out" the positive gains of the tertiary course. In some cases pragmatic concerns seem to mean that the practicum can be an uncritical apprenticeship based on the idiosyncrasies of the associate school and teacher, so there needs to be some consideration given as to how critical reflection can be brought to bear on the experience (Moore, 2003). In particular for mathematics education, mathematics educators and pre-service teachers need to consider not only the overt mathematics programs they experienced, but also the underlying beliefs and values that pervade the curriculum in the classroom and the feelings and attitudes of the children and teachers concerned.

This study also highlights the power of the school experience to shape and determine pre-service teachers' affective views about mathematics. Hence, if there is little change in the views of in-service teachers, then there is unlikely to be any long-term positive affective reform. This has implications for in-service teacher education in mathematics. While this study focussed on pre-service teachers, initiating and sustaining positive mathematical reform will be difficult if the only point of intervention is with the pre-service group. This seems to be one of the greatest challenges facing mathematics education at present.

Notes

- 1 Greater detail about the students' course can be found in Grootenboer (2003)
- 2 Pseudonyms are used throughout this article.
- 3 This point was illustrated in Grootenboer (2002) where case studies of two of the participants revealed that different practicum experiences resulted in different affective views about mathematics, despite the similarity of their perspectives prior to working in the classroom.

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Appendix A: Questionnaire Items

1. I believe that mathematics is important.
2. I appreciate the value of mathematics.
3. I have a positive attitude to mathematics.
4. I enjoyed my experiences of mathematics at school.
5. I believe that mathematics can enhance my life.
6. My school experiences have prepared me well to use mathematics in my life.
7. Mathematics is primarily concerned with arithmetic.
8. A person is either good or bad at mathematics.
9. You don't understand mathematics, you just do it.
10. School mathematics can be exciting and interesting.
11. All students can achieve in mathematics.
12. All students can enjoy mathematics.
13. Mathematics is a solitary activity done in isolation.
14. School mathematics has little to do with real life.
15. The advantage of mathematics is that things are either right or wrong.
16. Mathematics is a creative and dynamic activity.
17. Mathematics involves memorising rules and applying them mechanically to solve problems.
18. Mathematics education needs to "go back to the basics".
19. If you understand mathematics then you can always solve problems quickly.
20. A good thing about mathematics is that it is an unchanging subject.
21. Students learn mathematics best through exercises and plenty of practice.
22. Mathematics is primarily about computation.
23. Mathematics education involves exploring things in the world outside school.
24. Children should use concrete materials in mathematics.
25. I feel anxious about mathematics.