

Facilitating Affective Change With Preservice Primary Teachers

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There has been a concern for some time that preservice primary school teachers hold negative views of mathematics and their views influence their mathematical teaching practice. The participants in this study were involved in an initial course in mathematics education that deliberately set out to challenge their affective views of mathematics. The findings of the study indicated that some positive affective change occurred in the participants' beliefs about mathematics and their feelings and attitudes towards the subject. The aspects of the course that seemed to facilitate these changes are presented, followed by a discussion of some of the issues surrounding affective reform in mathematics for preservice primary teachers.

Over recent years there seems to have been a growing interest in the affective domain in mathematics education. Research in this area has included studies into beliefs about mathematics and mathematics teaching and learning (e.g., Schuck, 1997), values in mathematics education (e.g., Clarkson, Bishop, FitzSimons & Seah, 2000), attitudes towards mathematics (e.g., Way & Relich, 1993), feelings about mathematics (e.g., Carroll, 1994) and images of mathematics and mathematicians (e.g., Lim, 1999). In general, many of these studies seem to suggest that mathematics is an unpopular and disliked subject which is dogged by narrow and unhealthy perceptions of its nature. Indeed, it was this issue that motivated the current study.

Previous Studies

While interest in the affective domain in mathematics education seems to have swelled lately, studies in this area are not a new phenomenon with some significant foundational studies being undertaken many years ago. For example, Antonnen (1969) explored the relationship between attitude to mathematics and mathematical achievement over a six year period and found that there was a statistically significant correlation.

More recent studies are numerous, and they address the various facets of the affective domain using both qualitative (e.g., McDonough, 2002) and quantitative approaches (e.g., Nisbet & Warren, 2000). Many of the studies undertaken in Australasia were summarised and reviewed by Perry, Southwell and Howard (2000), and they suggested that; "significant studies have been undertaken into the espoused beliefs of teachers and student teachers" (p. 272). Since their review, other significant projects have also been undertaken, including the Values and Mathematics Project (VAMP) (Clarkson, et al., 2000).

In reviewing the studies undertaken over a number of years it is striking to notice the relative similarity of the findings in general. The similar, and generally sad picture that is portrayed seems to be consistent from era to era and country to country, indicating the universality of the problem and perhaps highlighting the need for some more focussed attention.

The Mathematics Education Course

The course on the learning and teaching of mathematics was a compulsory component of the first year of their teacher education program. It was undertaken in the first semester

and involved 24 two-hour workshop-type sessions over 12 weeks. The course was taught by two lecturers, one of whom is the author. The course rationale espoused a constructivist approach to its andragogy.

Theoretical Framework of the Course

The theoretical framework of the course was grounded in constructivist principles. However, constructivism is not a clearly defined single theory, but rather it has many forms including radical constructivism and social constructionism (Geelan, 1997).

Between the radical constructivist and social constructionist there are distinct differences, but they also share a great deal in common, and what is important is not whether individual cognition or social enculturation is primary, but how the two perspectives can be combined (Ernest, 1994). Bereiter (1994, p. 21) suggested that there was “nothing incompatible” between the two views and that “neither one implies rejection of the other”. Cobb (1994) promoted the need for both perspectives, suggesting that, “each of the two perspectives, the sociocultural [social constructionist] and the [radical] constructivist, tells half of a good story, and each can be used to complement the other” (p. 17). According to Cobb (1994), learning is both a process of socialisation into a greater community of practice and a process of active personal construction. In this respect, he views the radical constructivist and the social constructionist metaphors as complementary, each “constituting the background for the other” (Cobb, 1994, p. 19). Therefore, it was this perspective of constructivism that informed and underpinned the activities and learning of the course.

The Course Activities

The course addressed a number of aspects of teaching and learning mathematics including curriculum, planning and learning theory, but it also had a strong focus on the affective domain. In particular, there was an emphasis on the preservice teachers’ beliefs, attitudes and feelings about mathematics, and mathematics teaching and learning. While this occurred throughout the course, it was predominantly addressed in the early sessions. Alongside the activities, the preservice teachers were asked to keep a reflective journal, and discussion was often used to explore the issues that arose through the activities. In the following paragraphs some of these activities will be briefly outlined to contextualise the findings of the study (for more details of the activities contact the author).

Constructivist theory emphasises prior knowledge as the foundation for further learning, so initially the preservice teachers were asked to explore their history with mathematics, which largely related to their school experiences. As outlined previously, a number of researchers have found that individual’s affective responses to mathematics are grounded in their experiences in school classrooms (Carroll, 1994). To facilitate the exploration of these experiences, the participants were involved in activities including drawing pictures, writing stories, dramatising their recollections, and drawing graphs of their feelings. These activities seemed to enable the preservice teachers to recall and relive some of their mathematical experiences including all their associated feelings and beliefs. The rich and revealing memories they recalled were then open to review and reflective consideration through individual (journal writing) and collaborative (discussion) processes.

The preservice teachers were also asked to write simple similes or metaphors about mathematics. It has been suggested that metaphors can carry and convey peoples’ beliefs and values (Lakoff & Johnson, 1980). Hagstrom, Hubbard, Hurtig, Mortola, Ostrow and

White (2000) also noted in their work that; “metaphors open the fresh space of truth-telling, humour, powerful use of language, and image that hold the paradox and complexity of the human experience” (p. 27). Thus, it appears that metaphors bring together the affective positions and views of a person and their understanding of their experiences, and to this end they were employed in the course.

Another integral activity of the course was a field-trip to a local *bush clearing*. During the excursion the preservice teachers were involved in various mathematical activities in a natural outdoor setting. The activities were designed to be social, enjoyable and practical, and relate to the national curriculum. One of the prime reasons for undertaking the fieldtrip was to provide a counter-experience (a perturbation) to the dominant accounts of mathematics learning as being irrelevant, classroom bound and textbook based.

Finally, two sessions of the course were used to explore ‘mathematics in nature and the world around us’, through the Fibonacci Sequence and the Golden Section. The purpose of these sessions was to promote a sense of awe and wonder about mathematics, by presenting it as something aesthetic and connected to the world beyond a textbook.

The Study

The study focussed on the affective views of a group of 31 preservice primary school teachers in the first year of their initial teacher education programme. The participants were predominantly female (84%), and they were aged between 17 and 45, with 21 of them commencing their teacher education straight from secondary school. A relatively high proportion (55%) of the participants had no mathematics qualification from their time at school.

Data were collected at the beginning and end of their first course in the teaching and learning of mathematics using both qualitative and quantitative methods. The mixed-method approach was employed so the participants’ affective responses to mathematics could be monitored and described (Cresswell, 1997).

A 25-item, seven-point Likert scale questionnaire was used to monitor changes in the participants’ affective views. The items were developed after reviewing a number of studies that had employed Likert-scale questionnaires to research the affective domain in mathematics education (e.g., Nisbet & Warren, 2000).

The participants were also interviewed in small groups before and after the course. The interviews were conducted with groups of between two and five participants and they lasted between 25 and 70 minutes depending on the size of the group, the experiences being discussed and the willingness of the participants to engage in the dialogue. The interviews were generally characterised by lively and spontaneous discussion, and regularly they would comment on the similarities or differences in their experiences and at times they would empathise and comfort one another as their emotions were stirred by their responses.

Data were also generated through the course activities that were mentioned previously. These data collection methods allowed the participants to express their views and recount their experiences in different ways, while at the same time capturing the affective dimension of their experiences.

Findings

The general findings of the study indicated that the participants’ affective responses to mathematics improved through the course in mathematics education. The quantitative data

came from the participants' aggregated scores on the questionnaire. The lower scores indicate a positive view about mathematics and the higher scores indicate a more negative view. Paired-samples t-tests were conducted to evaluate the differences between the participants' scores on the questionnaire. There was a statistically significant decrease in the questionnaire scores from Time 1 ($M=95.76$, $SD=24.55$) to Time 2 ($M=67.17$, $SD=14.43$), $t(28) = 5.71$, $p < 0.001$. The eta squared statistic (0.54) indicated a large effect size. The boxplot below (Figure 1) highlights the changes in the participants' affective responses to mathematics as expressed in the aggregated data from the questionnaires.

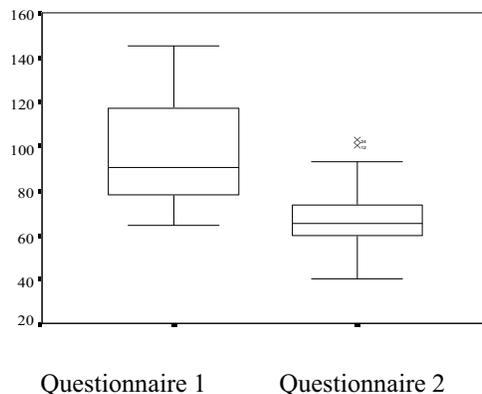


Figure 1. Boxplot of total questionnaire scores.

The quantitative data clearly indicated that there were some changes in the participants' affective responses to mathematics over the time of the study, and the qualitative data was collected to try and understand those changes.

Changes in the Participants' Affective Views

The study collected a large amount of qualitative data, but for the purposes of this paper only the aspects that related to the participants' experiences on the course will be reported. While the affective domain is complex, for the sake of discussion the data will be presented in the component parts of beliefs, attitudes and feelings.

Initially the participants' beliefs about mathematics reflected a Platonist perspective (Ernest, 1989) of mathematics as absolute and infallible. Mathematics was considered to be largely about number and arithmetic and characterised as routine and mechanical procedures. However, after the course the participants seemed to view mathematics in a broader and more sophisticated way. Many made comments about the usefulness of mathematics for everyday life, including Emma who said:

Maths is an important part of life - an essential tool, and I've only made that connection in the last few months. I mean, my schooling - maths was maths. I didn't consider that maths was anything else other than mental gymnastics. But now I have learned, and my children are learning, that maths is an important part of life. (Interview 2.4)

The participants still commented on the content of mathematics, but their perspective seemed to be more complex, and included aspects like problem solving and patterns. The participants also commented reflectively about the epistemology and philosophy of mathematics, generally revealing a more utilitarian view. In general, the data revealed a view of mathematics as a human activity, that is ubiquitous and that "helps us make sense of the world around us" (Sally, Interview 2.3). Overall, these views seem to be consistent with the course rationale (as stated in the official course outline).

The positive changes evident in the participants' beliefs about mathematics were similarly seen in their attitude to the subject. Most of the participants reported on their attitude after their tertiary course, and only one said that their attitude to mathematics was "still negative", and nine specifically talked of how their attitude was changing or had changed. Many of the participants who reported a positive change in their attitude to mathematics were pleased and excited about their new perspective, but they suggested that it wasn't an easy or completed process. Michelle commented:

I guess I still have a little bit of a hang-up about maths. I had a bit of a hang-up every morning that I had to overcome each day [she had mathematics education lectures] so it's a strange thing but slowly I am enjoying it. It's still something I have to get past, but yeah, slowly I am becoming more positive. (Michelle, Interview 2.1)

Closely associated with the participants' attitudes to mathematics were their feelings about the subject. Their initial feelings were almost universally poor, and it seemed as if their emotions were grounded in their experiences of mathematics at secondary school. This was not a new finding, so the participants' feelings about mathematics were overtly addressed in their mathematics education course, and there seemed to be some subsequent positive change in their emotional responses. Broadly speaking, the participants' feelings about mathematics seemed to be much more positive and many of the negative emotions were conspicuously absent in the data. The predominant feeling expressed by quite a few participants was confidence. The confidence they expressed was related to a broader conception of mathematics that wasn't limited to their school memories but was rooted in the course experiences and their perceived success:

My confidence levels have gone up. I had no confidence [before], but then on Monday when we were doing some work [in a mathematics education lecture] and [the lecturer] said to us "and that is algebra". I used to run a mile when I heard those words - algebra, trig and geometry, but I actually did it on Monday! (Louise, Interview 2.3)

Other participants also thought that they had subdued incapacitating emotions about mathematics, including Karen who said:

Through the lectures ... I think I have overcome my fear and hatred of maths because I can see the relevance of it so I will be able to teach it positively. (Karen, Interview 2.6)

Karen also addressed the issue of relevance, which for many tainted their feelings about the subject. Alongside feelings of confidence, over half of the participants acknowledged feelings of enjoyment and happiness. In many of these cases it seemed that their emotions were connected to the broader experience of the course in the learning and teaching of mathematics, including the personalities and characteristics of the course lecturing staff, but they associated their feelings to mathematics itself:

It was a just a whole new way of looking at things - it was incredible! That was an amazing experience for me and even now it makes me want to cry. I'm so happy! The passion of the lecturers was amazing. They really wanted to make a difference for us and the kids we teach. I felt loved and cared for as I had to negotiate some really tricky issues and now I quite like maths. (Naomi, Interview 2.6)

Others expressed positive emotions using adjectives and phrases such as satisfied, relieved, positive, motivated, excited, determined, amazed, incredible, "wanted to know more", and "can do it".

Although most of the data collected during the second phase concerning feelings about mathematics was positive, a small group of six (mostly older) participants were particularly anxious about a numeracy test (which was not associated with the course) they

had to sit. While these participants did express some negative emotions towards mathematics, their feelings weren't related to their mathematics education course. Furthermore, these were the only negative items identified in the data collected during phase two and so the overall feeling seemed to be positive.

Key Factors in the Participants' Affective Reform

After coding the data related to the participants' experiences on the course, four significant themes seemed to emerge concerning their affective changes: (1) the class atmosphere; (2) the course lecturers; (3) features of the course; (4) key events of the course.

Many of the participants identified the class atmosphere as being a critical dimension of the course. A fundamental aspect for many was that the atmosphere was quite different from their previous experiences of mathematics at school. Clearly part of this reflects the difference between a school and a tertiary culture, but there also seemed to be a sense of surprise that a course based on mathematics could be fun, enjoyable, relaxed and even inviting. For example, Nerolie said:

It was just the whole atmosphere. [The lecturers] were just so casual which just blew me away! For me that's WOW! Now my attitude is changing. ... (Interview 2.2)

As indicated by Nerolie above, the course lecturers were seen as foundational to the atmosphere of the classes, and a number of participants commented on their qualities and practices.

Just over half of the participants identified modelling as a positive feature of the course, suggesting that the lecturers enacted the theories, beliefs, values and practices they were teaching. In particular, many of the participants noted affective aspects of the lecturers' practice including their enthusiasm and passion for the subject, and the way they related to the student teachers as mathematics learners. Marina identified and commented on the lecturers' enthusiasm for mathematics as a motivating factor in her own development:

It has actually been the motivation that [the course lecturers'] excitement for maths has made me think, 'well there must be more to it than just what I've experienced in the past. That's probably the most important thing I've learned. (Interview 2.2)

Others thought that the lecturers had a passion for mathematics that extended to a zeal for them as mathematics learners and future mathematics teachers. Furthermore, many commented on the lecturers' relational approach, noting things like being approachable and available, being interested in the broader lives of the students, being "connected", and understanding and empathising with the students. For example:

[The lecturers] actually made an effort to get to know each of us and liked to talk to us in the corridors and I found that really good. It actually made me feel more confident. ... They taught from relationship and they like, got to know you and could help out. And I found that was probably the best thing about the course because it was so different from school because at school they didn't seem to bother with that. They didn't like to find out where you were at and so teaching from relationship, I think that was the thing that was really good stuff. (Kylie, Interview 2.3)

Apart from the lecturers, the participants identified some other important influential features of the course including the collaborative approach and the inclusion of practical examples. To work collaboratively in a mathematical context was reported as a new experience by a number of the participants. These participants suggested that "working together" was important because they could understand the views and experience of their

colleagues while supporting one another as they considered critically their own mathematical views, beliefs and feelings. They also indicated that the collaborative approach challenged their conceptions of mathematics as an isolated individual activity. The incorporation of “hands-on” practical activities was also seen by some as important as they reconsidered their views of mathematics. For example:

It [mathematics] was a lot more practical than I had ever experienced. I did a lot of adding and subtracting but I had never seen algebra used in practical ways before. (Helen, Interview 2.4)

Again, for many of these participants it appeared that seeing mathematics as practical was quite novel, particularly in an educational context.

Finally, the participants were able to identify some of the particular events in the course that facilitated their affective dissonance. The events that were most prominent in the data were the sessions where they specifically reviewed their own mathematical history, the first assessment assignment, the lectures/workshops on the Fibonacci Sequence and Golden Section, and the field trip (outlined previously). In particular, these activities seemed to prompt and support positive affective change for the participants.

The reviewing of their mathematical experiences at school was one of these events, and for a number of students in the course, these sessions were quite emotional and even painful. Despite the traumatic nature of these experiences, many of the participants identified them as being a crucial part of the course. For example:

I loved the whole thing [the course] once we got past that dredging up all our past - I had to get counselling from my pastor you know! It was terrible going over all that again but I can see now that it was worthwhile - essential to me becoming a teacher and a whole person. (Naomi, Interview 2.6)

For others, the ability to identify, record and discuss their feelings and attitudes to mathematics in the context of their school experiences was the start of rebuilding a new conception of mathematics.

Concluding Comments

There appears to be a significant amount of literature to suggest that the problem of preservice teachers’ affective responses to mathematics is well known. If we can then accept the problem as a given, the next issue is how can the situation be addressed? Clearly the apparent long history of the issue indicates that solutions and pathways ahead are not easily found or universally successful. Nevertheless, there seems to be a compelling case to try and do something about it if mathematics education is to be released from the continuing cycle of negativity.

The activities and pedagogy of the mathematics education course reported on in this paper seemed to have had some success in helping these preservice teachers improve their affective responses to mathematics. While one can celebrate the positive gains that were evident, there is a lingering doubt as to their adequacy and sustainability once the participants move onto the other aspects of their teacher education program that do not focus on mathematics. However, the data indicated that the affective changes were genuine and sincere, and therefore, perhaps in some small way, the poor perception of mathematics that seems to prevail has been challenged.

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