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The Legacy of Schooling: Student Teachers' Initial Mathematical Feelings and Competence

Fred Biddulph
University of Waikato

Government policies in New Zealand have lead to four-year primary teacher education degrees being reduced to three years. In the process, mathematics teacher education, at least at the University of Waikato, has been reduced accordingly. This has prompted a serious consideration of primary student teachers' initial feelings/attitudes about, and understanding of, mathematics. Data collected from 242 beginning student teachers about their feelings/attitudes, and from 166 regarding their understanding, are reported in this paper. The results show that a significant proportion of the students have deeply negative feelings and attitudes, and lack understanding of relatively simple mathematics. Suggestions for addressing the lack of understanding are sought.

Introduction

For a number of years Mathematics Education staff at Waikato have been aware that many of our beginning primary teacher education students have quite negative feelings about mathematics, and that some struggle with a number of the basic concepts found in mathematics at the primary level. We are not alone in this respect. Several mathematics educators in Australia have investigated and reported on this issue. For example, Bobis and Cusworth (1994, 1995) studied preservice teachers' attitudes towards mathematics, and the effect of mathematics education courses on these; Carroll (1994a, 1994b) investigated why some preservice teachers have developed 'maths phobia' and the impact this has on their participation in mathematics education courses; Schuck (1996) found that some primary teacher education students are shackled to their past experiences in mathematics, and that such chains are not easily broken; Kaminski (1997) explored teacher education students' number sense and concluded that, "Overall, the pre-service teacher education students in this study displayed an undeveloped sense of number" (p. 233).

Several action-research studies (Biddulph, 1992; Buzeika, 1996; Carr, 1992; Clarke & Clarke, 1996; Clarkson, 1998; Schuck, 1996; Taylor, 1996; Van Zoest, Jones, & Thornton, 1994) have also tried to address the above issue. Some success is evident in changing student teachers' negative attitudes towards mathematics but, in the time available, improving their mathematical understanding has proved to be far more problematical. This is a serious concern because, in Clarkson's (1998) view, students with long term mathematics problems can harm pupils if their mathematics insights do not develop. It becomes even more serious when, as Clarkson (1998) says, university downsizing means that we are no longer in a position to help these mathematically-at-risk beginning teachers. At Waikato, for instance, the need to reduce our four-year Bachelor of Education degree to a three-year Bachelor of Teaching degree to remain competitive with teacher education

programmes offered by other New Zealand tertiary institutions has meant a reduction in required mathematics/mathematics education to one and a half courses in total (out of 21) for primary preservice student teachers.

This stark reality of extremely limited time for mathematics education prompted us to look more closely at the issue of our beginning students' affective state with respect to mathematics, and also to gain some initial idea about their conceptual understanding (without, if possible, deepening their aversion to mathematics). This paper reports on data collected to address these issues.

Data Collection

Data about attitudes towards mathematics were collected in the initial session of the first-year mathematics education course from 76 year-one students at the beginning of the second semester of 1997, and 166 year-one students at the beginning of the second semester of 1998. The students were invited to write responses to the following:

I would describe my present feelings about mathematics as... because....

In the case of the 1998 students, they had already responded to six short questions about mathematics (see Appendix 1) before they described their feelings. Both groups of students were asked to indicate the highest level of mathematics they had studied.

It should be noted that the results do not include data from Rumaki (Maori immersion) groups (Herewini, 1998) who were undertaking their mathematics education through the medium of the Maori language. Such data would probably be worth collecting and analysing in its own right.

Results and Discussion

The results are summarised in Tables 1-4. These set out data about: (a) the highest level of mathematics at which the students said they had studied, (b) their reported feelings about mathematics (including comparison with those of a representative sample of New Zealand primary school children), and (c) the 1998 students' understanding of several basic mathematical concepts.

Highest Level of Mathematics Studied

On the face of it, these data (see Table 1) suggest that most of the students should have sufficient understanding to teach mathematics at the primary/intermediate (Years 1-8) school level, but unfortunately the figures do not disclose that an appreciable number of the students mentioned that they had really low marks/grades in mathematics.

Table 1
Highest Level of Mathematics Studied by Teacher Education Students

Level	1997 Students[a]	1998 Students[b]
Secondary Form 3/4	6%	8%
Secondary Form 5	41%	30%
Secondary Form 6	37%	35%
Secondary Form 7	13%	27%
No response	3%	0%

Note. [a]$n = 76$. [b]$n = 166$

How Students Felt about Mathematics Initially

Table 2 discloses that roughly one-third of students felt "fine" (positive) or "okay" (neutral) about mathematics, but between one-half and two-thirds had distinctly negative feelings about the subject. The greater percentage of students with negative feelings in 1998 is possibly due to their having just attempted to answer six relatively simple mathematics questions.

Table 2
Students' Reported Feelings about Mathematics

Feeling	1997 Students[a]	1998 Students[b]
Positive	22%	28%
Neutral	16%	8%
Negative	54%	64%
Not stated	8%	0%

Note. [a]$n = 76$. [b]$n = 166$

Students who reported feeling positive about mathematics expressed views that ranged from feeling comfortable, to interested, to liking it, to feeling confident about it, to having a love of numbers and problem solving, to finding it really enjoyable. Typical of the last category of responses was that of a 1998 student. "I've always enjoyed maths. It's always been my favourite subject." This student's confidence, along with most others who felt positive about mathematics, was well placed as she had responded correctly to all six mathematics items. However, a small minority seemed to have misplaced confidence in themselves, such as the student who said that although he felt a bit rusty, he was, "really good at maths." This student had studied mathematics to Form 7, but nevertheless had responded incorrectly to Items 1, 5, and 6.

The students in the neutral category were those who had no strong feelings, or mixed feelings, about mathematics. They also included some students who said they felt average or indifferent about mathematics, or they felt confident in some areas but not others.

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. Typical responses included,

> Bit nervous. I'm having trouble answering these questions. How am I meant to teach something I don't understand?
>
> I'm not interested because I have always had problems working through fear of always having the incorrect answer.
>
> I am scared of maths; I avoid it wherever I can [because] I was the worst at maths for as long as I can remember.
>
> I hate it. I can't do it. I can't remember anything. I've never been good at it and I just don't want to try to do it.
>
> I feel a failure because I had to go to tutoring in 5th form and still only got 63%, and 6th form I failed. Also my teacher yelled at me when she found out I was going to tutoring, and sent me to the principal, and put me off for life.

It is interesting to compare the attitudes of these beginning teacher education students with those of New Zealand Year 4 (8-year-old) and Year 8 (12-year-old) children as reported by Flockton and Crooks (1998). The National Education Monitoring Project (NEMP) asked 2872 Years 4 and 8 children how much they liked doing mathematics at school. Their responses are compared with the student teachers' responses in Table 3.

Table 3
Children's and Student Teachers' Reported Feelings about Mathematics

Year	Positive	Neutral	Negative	No Response
4	52%	31%	17%	0%
8	25%	49%	36%	0%
1997 students	22%	16%	54%	8%
1998 students	28%	8%	64%	0%

Table 3 reveals that by the end of their primary/intermediate schooling only about one quarter of the children remain positive about mathematics, and this percentage is similar to that among the beginning teacher education students. On the other hand, the percentage of students reporting a negative attitude rises steeply from Year 4 (less than one-fifth) through Year 8 (more than one-third) to first year teacher education (more than one half). The slide into dislike for mathematics appears to have begun relatively early for many learners. Of course, the beginning teacher education students do not represent a cross-section of secondary school leavers so it is probably unfair to compare them with the general population of children represented in the NEMP results. They are, nevertheless, a subset of that population, but whether their dislike for mathematics stems from their primary years or later secondary schooling is an open question. The reports of many teacher education students who have undertaken an optional final-year curriculum development course in mathematics suggest that in most cases their negative experiences developed in the course of their secondary school mathematics

education. Whichever is the case, these negative feelings tend to be deeply ingrained and require a sustained period of understanding support to overcome.

Students' Understanding of Mathematics

The results in Table 4 indicate that less than half the students understood the independence concept in probability, and also place value with respect to measurement of length. This result did not surprise us, but it certainly gives us cause for concern.

Table 4
1998 Students' Understanding of Some Basic Mathematics Concepts (N = 166)

Items	% Students Correct
1. Probability – independence concept	47%
2. Volume	76%
3. Subtraction – mental	81%[a]
4. Multiplication – simple decimal	72%
5. Simple fraction	77%
6. Measurement – place value, decimal	44%

Note. [a]Of the 81% of students who responded correctly, 46% used number sense, while 35% used a mechanical approach which suggested a lack of number sense.

The students' efforts on the other four items might suggest that on these they performed relatively well. However, these results too give us serious concern. With respect to the volume item (No. 2) most students simply halved the volume and wrote $5cm^3$, which was acceptable; only one student interpreted the item as meaning that each dimension should be halved, hence resulting in a volume one-eighth the original. What was really surprising was that almost one quarter of the students could do neither. One wrote that she was not sure about the cube sign; perhaps that was also the case with others.

Other examples of inappropriate thinking were elicited from Items 4 and 5. For instance, one student worked out that 18 x 0.5 is 9 (Item 4) but then said that 9 x 1 equals 9. Another student found out that 6 was two-thirds of 12 (Item 5) by taking 12 pencils and crossing out two sets of 3. The concern, of course, is that expressed by one of the students above who asked, "How am I meant to teach something I don't understand?" It is a concern expressed by Australian mathematics teacher educators as well (see, for example, Clarkson, 1998). In Clarkson's case, this was despite attempts to help the students via an innovative semester unit on mathematics itself.

Conclusion

A conclusion to be drawn from these results is that special provision needs to be made to help many students overcome both their deep-seated fears about mathematics, and their lack of knowledge in the area. This is all the more so when it is recognised that the view of mathematics contained in recent curriculum

documents is in a quite different paradigm from the perspective gained by almost all students through their own schooling experiences. Perhaps, as Adey (1998, p. 22) has recommended, "There should be provision, if required, for remedial, bridging or other courses" because,

> Graduates should be able to effectively contribute to their students' numeracy development. They should themselves be adequately and confidently numerate, and possess knowledge and understanding of numeracy as a fundamental component of learning, performance, discourse and critique....They should appreciate numeracy as involving the ability to use a combination of:
>
> - underpinning mathematical concepts and skills across the discipline (numerical, spatial, graphical, statistical and algebraic);
> - mathematical thinking and strategies;
> - general thinking skills; and
> - grounded appreciation of context. (p. 14)

This is a big ask for many of our first-year students, but it is entirely necessary for the future of mathematics education in New Zealand. As one of the first-year students commented, when asked what she felt her greatest needs are as far as mathematics is concerned, "At this stage, probably a refresher course in everything!" The difficulty for us lies in providing such a refresher course. For one thing, there is virtually no space in our current three-year Bachelor of Teaching degree, given the way it is presently designed. Secondly, if such space could be made available then we would be likely to encounter problems having a course in primary mathematics accepted as a university course by the New Zealand universities which act as the accreditation authority for university courses in this country. Thirdly, if the universities could be convinced, then Mathematics Department staff (who are not located within the School of Education) would almost certainly want to teach the course, probably with detrimental results. Perhaps a way forward is to produce a teacher-friendly written resource, or maybe an on-line tutorial for primary student teachers to access in their own time. It is a dilemma, and we welcome discussion and suggestions from other mathematics teacher educators.

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Author

Fred Biddulph, School of Education, University of Waikato, P.B.Bag 3105, Hamilton NZ. E-mail: <fredb@waikato.ac.nz>

Appendix

Survey

1. A coin is being tossed to find out who will start with the ball in a netball game. So far the team you support has played eight games in a ten game tournament. Each time the toss has been heads in favour of your team starting. What do you think the next toss will be?

   Why do you think that?

2. You have been asked by a company to design a box that is half the size of one presently used. If the present box is $10cm^3$, what would the volume of the new box be?

3. Work out in your head the difference between 153 and 88.

   Can you please write down what you said to yourself as you did this.

4. How would you do this mentally? 18 x 1.5?

   Write down your thinking.

5. You are intending to work with a group of 12 children for art, all of whom need one pencil. You notice the pencils all need sharpening. How many pencils have you still got to do?

   How did you work it out?

6. A new pipe needs to be bought to fix a leak in the bathroom. You buy a 3.25cm diameter pipe. What does the 5 mean?

Note: Item No. 2 was deliberately phrased in this way to see how the students would handle the ambiguity involved.