Monitoring Change in Attitude of Preservice Teachers Towards Mathematics and Technology: A Longitudinal Study

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This paper reports on the quantitative data gathered during the second and third years of a 5 year longitudinal investigation into the attitudes of preservice primary teachers towards mathematics and toward the teaching of this subject. Findings indicate that teacher education programs can improve the attitudes of preservice teachers towards mathematics, and that this shift in attitude can continue to improve well into the first year of teaching.

The prior experiences of preservice teachers can not only have long lasting repercussion on the way they teach mathematics, they can also impact upon the outcomes of their students. Research findings link teacher attitudes toward mathematics with student attitudes and achievement levels in the subject (Bishop & Nickson, 1983; Schofield, 1981). In addition, work completed by Ernest (1988) suggests that teachers' attitudes toward the subject may affect their attitudes towards the teaching of the subject, which in turn impacts upon the ethos and culture of the mathematics classroom, which in turn impacts upon the attitudes of their students. Hence, a cycle of poor attitudes and poor achievement levels can spiral from generation to generation. Given the evidence indicating that a majority of prospective primary teachers hold negative attitudes toward mathematics (Ernest, 1988; Sullivan, 1987) it is imperative that shifts in attitude to the subject be an affective outcome of teacher education programs with the intention of stopping this spiralling effect. However, this desired outcome begs the question: Does preservice teacher education really make a difference to prospective teachers' attitudes towards mathematics and mathematics self-concepts? If so, how long does this affect last?

Schuck (1996) suggests that prior experiences are responsible for existing beliefs and attitudes that act as "chains" inhibiting movement towards reform in the way mathematics is taught in schools. We are in agreement with her proposition that knowing the nature of these constraints can help in shifting the attitudes of preservice teachers toward more favourable ones. Further to this, it is our premise that monitoring such shifts in attitude can facilitate the movement towards more positive ones as teacher education programs undergo restructuring and take account of the monitoring process in their course designs. The importance of such monitoring is acknowledged by Relich, Way and Martin (1994) in their work to develop a reliable and valid instrument to evaluate student attitudes so as to gauge the success of teacher education programs in this area.

This paper provides an update of a longitudinal research project begun in 1993 which aims to "investigate the attitudes of two groups of preservice primary school teachers toward mathematics and science/technology and toward the teaching of these subjects as they begin their teacher education". Furthermore, it seeks "to monitor these attitudes as the students progress through their respective teacher education programs...and to follow these students into their first years of their teaching careers" (Bobis & Cusworth, 1994a, p. 115). This paper, as have previous papers presented at MERGA conferences (Bobis & Cusworth, 1995; 1994a), focuses solely on the findings relating to mathematics. While the on-going investigation utilises the multiple data gathering techniques of questionnaire, structured and semi-structured interviews and reflective journals, only findings from the questionnaire will be included in this report.

Method

Participants

Participants were preservice primary-school teachers enrolled in their third year of a Bachelor of Education (BEd) program at the University of Sydney and graduates of the Diploma of Education (DipEd) program with one year's teaching experience. While 138 (83 BEd and 55 DipEd students) responded to round 1 of the questionnaire, 93 students (47 BEd and 46 DipEd) completed the questionnaire in round 2 and 67 students (42 BEd 3rd year students and 25 DipEd graduates) completed it in round 3.

The Questionnaire and Procedure

The questionnaire used in rounds 2 and 3 of the investigation was the same used during round 1, but some items were changed slightly in round 3 to reflect the teaching status (that is, one year of teaching experience) of Diploma of Education graduates. The Attitudes Towards Mathematics questionnaire used in the study has been presented in detail previously (Bobis & Cusworth, 1994b), but will be described briefly here. In short, the instrument was a modification of Relich and Way's (1992) instrument designed to assess attitude toward mathematics and was reformulated to incorporate attitude toward teaching mathematics with the aid of technology (namely, calculators and computers). The final version was a 24 item, Likert-type instrument comprising 3 scales: an attitude to teaching mathematics (ATM) scale (11 items), a mathematics self-concept (MSC) scale (9 items), and an attitude to teaching mathematics with technology (ATMT) scale (4 items). Each student received 3 scores - one for each of the attitudinal dimensions of the questionnaire. These scores were the algebraic sum of the individual items in each of the dimensions. Higher scores represent more positive attitudes.

Table 1 summarises the data gathering procedure for the first 3 years of the investigation. Results of stages 1 and 2 have been reported at previous MERGA gatherings (Bobis & Cusworth, 1994b; 1995) and will only be referred to in this paper so that comparisons can be made with new findings.

Table 1 Summary of data gathering procedure for each group of subjects at each stage of the study.

Date	Stage	DipEd	BEd
February 1993	1	Round 1 of Questionnaire, general background survey and initial interviews.	Round 1 of Questionnaire, general background survey and initial interviews.
November 1993	2	Round 2 of Questionnaire and follow-up interviews.	
February 1994	3		Reflective Journals kept by BEd students.
November 1994	4	Round 3 of Questionnaire completed by 54% of graduates after one year's teaching experience. Follow-up interviews.	Round 2 of Questionnaire and follow-up interviews.
November 1995	5		Round 3 of Questionnaire and follow-up interviews.

For BEd students, round 2 of the questionnaire occurred at the end of 1994. Since no professional education subjects were undertaken in their first year of tertiary education, the questionnaire was considered unwarranted at the end of 1993. By round 3

of the questionnaire BEd students had completed three mathematics education subjects - one of which focussed on the use of computers.

Results and Discussion

In this section results for DipEd and BEd students will be reported separately. While some comparisons between the results of the two groups will be made in the discussion, it is considered inappropriate to make definitive comparisons when BEd and DipEd were at different stages of their careers for rounds 2 and 3 of the questionnaire. Table 1 presents the Diploma of Education group's mean scores and standard deviations for each round of the questionnaire and Table 2 presents the Bachelor of Education group's results.

Diploma of Education

It is clear from Table 2 that scores for each subscale of the questionnaire continued to improve for each of the domains even after the DipEd group had graduated and been teaching for one year. The greatest improvement occurred for the attitude toward teaching mathematics (ATM) domain at both rounds 2 and 3. Two tailed t-tests were used to determine if there were significant differences between the mean scores calculated for rounds 2 and 3 on each subscale. There was a significant difference for ATM at this stage in the study ($t = 3.282$, $t < 0.05$). Previous findings had also revealed a significant difference between the ATM mean scores of rounds 1 and 2 ($t = 3.5$, $p<0.05$). This means that students' attitudes towards the teaching of mathematics improved significantly at each round of the questionnaire, both during the time spent in their teacher education program and during their first year of teaching.

Table 2 Mean scores and standard deviations for each subscale for rounds 1, 2 and 3 of the questionnaire (DipEd only).

Factor		Dip Ed		
		Round 3	Round 2	Round 1
		n =25	n = 46	n = 55
Attitude to teaching mathematics (Max = 55)	mean	43.1	38.5	33.1
	SD	11.2	8.1	8.7
Self-Concept (Max = 45)	mean	32.3	31.1	29.5
	SD	8.5	9.5	8.1
Attitude to teaching with technology (Max = 20)	mean	15.8	15.0	13.6
	SD	4.0	3.1	4.4

While each round of the questionnaire revealed an improvement in math self-concept (MSC), consecutive rounds did not yield significant results ($t = 1.9$, $p>0.05$ and $t = 1.3$, $p>0.05$, respectively). However, the difference between MSC mean scores at the start of the DipEd program (round 1) and those after one year of teaching (round 3) were significant ($t = 2.5$, $p < 0.05$). The difference between the mean scores for each round of the questionnaire were 1.6 and 1.2 respectively. This means that, like the ATM of DipEd students, math self-concept continued to improve (though at a slightly less rate)

after they had been teaching for one year. This finding is of particular interest, since the resilient nature of self-concept as compared to attitude has been noted by other researchers in this field (Relich and Way, 1993).

While there was a significant difference between mean scores for attitude toward teaching mathematics with technology (ATMT) at rounds 1 and 2 ($t = 3.5$, $p<0.01$), the increase in mean score for ATMT between rounds 2 and 3 was not significant ($t = 1.3$, $p>0.05$). This indicates that after their initial improvement in attitude toward teaching with technology there had been little subsequent improvement.

Bachelor of Education

As can be seen from Table 3, the mean scores of Bachelor of Education students on each subscale of the questionnaire also improved at each round. Similar to the DipEd group, greatest improvement occurred for the attitude toward teaching mathematics domain with a mean difference of 11.4 between rounds 1 (the start of the program) and 3 (at the end of their third year in the BEd program). Two tailed t-tests were used to determine if there were significant differences between the mean scores calculated for round 3 and previous rounds on each subscale. While there was a significant difference between the mean scores for ATM at round 1 and round 2 ($t = 7.1$, $p< 0.0001$), there was no significant difference for ATM between rounds 2 and 3 of the questionnaire ($t = 0.9$, $p>0.05$).

Table 3 Mean scores and standard deviations for each subscale for rounds 1, 2 and 3 of the questionnaire (BEd only).

Factor		BEd		
		Round 3	Round 2	Round 1
		n = 42	n = 47	n = 83
Attitude to teaching (Max = 55)	mean	43.2	41.8	31.8
	SD	7.4	9.2	8.1
Self-Concept (Max = 45)	mean	33.9	32.4	30.8
	SD	7.6	7.8	7.8
Attitude to teaching with technology (Max = 20)	mean	16.9	15.7	12.3
	SD	2.5	3.1	4.7

There were significant differences for ATMT between rounds 1 and 2 ($t = 4.0$, $p<0.001$) and between rounds 2 and 3 ($t = 2.6$, $p < 0.01$) indicating that attitudes toward the use of technology in teaching mathematics improved significantly at each round of the questionnaire. Further analysis of these scores was conducted since comments made by DipEd students during previous rounds of the questionnaire and in interviews indicated that the attitudes of many students toward calculators and computers differed quite significantly. Results showed that BEd students' attitudes towards the use of calculators and computers had both improved significantly by round 2 of the questionnaire ($t = 3.6$, $p<0.001$ and $t = 3.6$, $p<0.001$ respectively), but round 3 results indicated that only students' attitudes towards the use of calculators had improved significantly from those found in round 2 ($t = 3.5$, $p<0.05$). This finding was interesting given the fact that a significant amount of practical instructional time was allocated to the use of computers prior to round 3 of the questionnaire for BEd students. It is hoped that analysis of

interviews conducted shortly after the questionnaire was completed may shed some light on this finding.

There were no significant differences between the mean scores for MSC in rounds 1 and 2 ($t = 0.7$, $p>0.05$), in rounds 2 and 3 ($t = 1.5$, $p>0.05$) or in rounds 1 and 3 ($t = 1.6$, $p>0.05$), indicating that the mathematics self-concepts of BEd students had not improved significantly in the three years that they had been monitored by this investigation. Unlike the DipEd finding of round 3, this result is in accordance with the suggestions by Relich and Way (1992) concerning the resilient nature of self-concept and highlights how critical it is to foster positive self-concepts from a very young age. While the mathematics self-concept of DipEd graduates improved significantly when the MSC mean score from round 1 was compared to the MSC mean score achieved after one year of teaching, it remains to be seen if the same will occur for BEd graduates after their first year of teaching.

Summary and Conclusions

Findings indicate that both DipEd and BEd groups improved their mean scores on all three subscales at each round of the questionnaire, though the improvements were not always significant or at the same rate for the two groups. At each round, attitude toward teaching mathematics had the greatest improvement, indicating that it is easier to shift this domain than the others. It is interesting to compare the attitude to teaching mathematics mean scores of the DipEd with those of the BEd at each round. While there was little difference between the mean scores at the start of their education programs, there was greater improvement in BEd students while still undertaking their teacher education and it was not until DipEd graduates had taught for one year (round 3) that the two groups achieved similar mean scores on this domain. Since the BEd students still have another year of teacher education, it is likely that their scores on this domain will continue to rise. It is possible, however, that attitude scores may reach some peak and then plateau. If this is the case, then it will be interesting to determine the career stage that this occurs for each group.

The results so far also suggest that the improvement in attitude toward teaching mathematics and math self-concept of DipEd graduates as a consequence of their initial teacher education is deep enough to not only remain more positive but to continue to improve well into their first year of teaching. The reasons for improvement are not evident from the quantitative data presented here, but it is hoped that analysis of interview data may shed some light on these reasons. Subsequent rounds of the questionnaire will determine if scores on each of these domains actually plateau or whether they start to drop back at some stage of their careers.

Of particular interest is the finding that mathematics self-concept improved significantly for the DipEd group between rounds 1 and 3 of the questionnaire. While this domain has been shown to be particularly resilient to change, it has never before been monitored in a group of subjects spanning this length of time or followed-up after a year of teaching experience. While the mathematics self-concept of the BEd group has not yet improved significantly, it is possible that it will continue to improve in their fourth year of the program and their first year of teaching as it did for the DipEd.

Findings also indicated that improvement in attitude towards teaching mathematics with technology slowed dramatically during the first year of teaching. This could be explained partly by the lack of technology and technological assistance in most primary schools, but interview data may reveal other reasons for this phenomenon. While BEd students' attitudes toward teaching with technology improved significantly at each round of the questionnaire, further analysis revealed that much of this improvement was attributable to an improved attitude toward the use of calculators. Computers remained a source of anxiety for BEd preservice teachers, despite having used them extensively to tutor school-aged children during mathematics education tutorials. This has significant implications for the integration of computers into teacher education programs.

If by improving preservice teachers' attitudes and self-concepts to mathematics we can initiate some impact upon classroom instructional practices and ultimately on children's attitudes and achievement levels in mathematics, then the findings of this longitudinal study are certainly reassuring. The results show that it is possible for teacher education programs to shift the attitudes and mathematics self-concepts of preservice teachers to more positive ones and that these shifts can continue to improve well into the first year of teaching. Whether a plateau will eventually be reached by this continual shift in attitudes or some other trend will manifest itself, can only be determined by subsequent rounds of the questionnaire and data collected from interviews. In addition, the fact that teacher attitudes toward mathematics and mathematics self-concepts continued to improve after one year of teaching experience - but at a slower rate than evidenced during their initial teacher education - highlights the importance of ongoing professional development during teaching rather than "one-off" teacher preparation.

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