Dispelling the Myths: Influencing the Beliefs of Preservice Primary Teachers

Kim Beswick
University of Tasmania
<kim.beswick@utas.edu.au>

Shelley Dole
University of Tasmania
<shelley.dole@utas.edu.au>

This paper describes a preliminary investigation of some of the beliefs held by preservice primary teachers at the commencement of their mathematics education studies and at the end of the first of a sequence of three mathematics education units. The beliefs of this cohort will be monitored in subsequent years with a view to identifying factors that influence them in a positive direction. Initial results provide promising evidence that mathematics education courses can, within current university resourcing constraints, influence the beliefs of preservice teachers.

The beliefs of mathematics teachers have been recognised as key factors in explaining the failure of repeated attempts to reform mathematics education to positively impact either the cognitive or affective outcomes for students (Southwell, 1995). Indeed, it is futile to provide curricula and materials for teachers to use without addressing the beliefs of the teachers (Anderson & Piazza, 1996; Battista, 1994). Recently, the importance of teacher beliefs has been given prominence in policy documents and various numeracy projects. For example the Commonwealth Numeracy Policies for Australian Schools (DETYA, 2000) states that, "Teachers beliefs, knowledge, understandings and skills are critical factors in students' numeracy development." (p. 23), and highlights the importance attached to teachers' beliefs in both the Early Literacy Research Project, in Australia, and the Effective Teachers of Numeracy project in the U.K. Teacher educators are clearly in a position to play a key role in ensuring that teachers in future years hold beliefs about mathematics and its teaching that are likely to facilitate the implementation of reform in mathematics education.

The Beliefs of Preservice Primary Teachers

During the 1980s and 90s there has been growing interest in the beliefs of teachers and increasingly on their relationship to classroom practice (Thompson, 1992). This research has been conducted alongside research regarding the attitudes of teachers towards mathematics that began in earnest in the 1970s (McLeod, 1992). While the distinction between attitudes and beliefs and is often not clearly made, McLeod (1992) suggests that attitudes are similar to beliefs but with a lesser cognitive component and a greater affective component. A particular aspect of the research on attitudes is the study of the phenomenon of mathematics anxiety. Measuring this construct has proven difficult and interpretations of studies aimed at identifying the extent of the problem among various groups have been questioned to the extent that some express doubt as to its existence as a construct separate from general anxiety (Wood, 1988). Wood (1988) goes on to say, however, that inspite of this, research in the area has established that many preservice primary teachers have negative attitudes to mathematics and regard the subject with considerable fear. In their work with mathematics anxious and mathematics avoidant

students Kogelman and Warren (1978) identified a set of twelve beliefs about mathematics that are commonly held by such people. In her study of 131 preservice primary teachers Frank (1990) found that suprising numbers of these students held these same beliefs.

While subsequent studies have not investigated the presence or otherwise of these particular beliefs they support the general conclusion that students enter primary teacher education programmes with beliefs about mathematics that are not helpful. They have been characterised as traditional (Civil, 1993; Mayers, 1994; Wilcox, Schram, Lappan & Lanier, 1991). That is, preservice primary teachers hold beliefs that are likely to lead to teaching that emphasises exposition, practice and memorisation. Bobis and Cusworth (1995) found that even those with both positive attitudes and self-concepts with regard to mathematics view the discipline narrowly, equating it with number, and attributing their own perceived success to an ability to memorise procedures. These views are primarily based on the students' own experiences of learning mathematics (Sullivan, 1987) and are hence well ingrained and difficult to change by the time students embark on their tertiary education (Bobis & Cusworth, 1995; Wilcox et al., 1991).

Changing the Beliefs of Preservice Primary Teachers

From the literature describing various attempts that have been made to modify the beliefs of prospective teachers, it is possible to identify a number of features of courses that are likely to be successful in producing desirable change. These include having preservice teachers actually engage in doing mathematics (Anderson & Piazza, 1996; Civil, 1993; Wilcox et al., 1991); the use of collaborative group work (Civil, 1993; Schuck, 1998; Wilcox et al., 1991); increasing awareness of and encouraging reflection on the students' own beliefs (Malone, 1995; Schuck, 1998, Stuart & Thurlow, 2000); encouraging reflection on their practice teaching (Malone, 1995; Van Zoest, Jones, & Thornton, 1994); and providing alternative models for mathematics teaching (Anderson & Piazza, 1996; Malone, 1995; Malone et al., 1997; Van Zoest et al., 1994).

Attempts to change the beliefs of preservice primary teachers have been interventions in the form of modifications to existing mathematics and mathematics education courses in an attempt to incorporate more of these factors. Modifications have included the elimination lectures as the principle mode of instruction (Anderson & Piazza, 1996); the use of carefully planned and monitored teaching practice (Malone, 1995; Van Zoest et al., 1994) and the use of technology (Schuck, 1998). In addition, the increased focus on small group collaborative work that is a feature of many interventions (e.g. Wilcox et al., 1991) implies decreased prominence of lectures in course delivery and an increase in the use of tutorials. All of the above are likely to require substantial additional resources, particularly if implemented with large cohorts of students.

Implications for This Study

This study was designed to begin to assess the effectiveness of existing mathematics education courses in influencing the beliefs of preservice primary teachers in a positive direction so that the potential benefits of making changes along the lines of those described in the literature could be weighed against the costs involved. Clearly, if widespread and

lasting positive changes to the attitudes and beliefs of preservice teachers are to be achieved they must be the result of interventions that are readily replicable within the real constraints of current university teaching environments. Initial questions were:

- To what extent do current beginning preservice teachers hold the damaging beliefs identified by Frank (1990)?
- Are existing mathematics curriculum courses effective in changing the beliefs of preservice teachers?

Future research will be aimed at monitoring the ongoing developments in the beliefs and attitudes of this cohort as they progress through subsequent mathematics education units. These investigations will focus on obtaining a more complete picture of the beliefs about mathematics and its teaching that the students hold, and specifically at identifying which aspects of the courses are most effective in producing desirable changes, and hence where changes can be made to maximize positive outcomes.

The Study

Subjects

The subjects of the study were approximately 200 students enrolled in the first mathematics component of their B. Ed. (Primary & Early Childhood) programme. This occurred in the second year of their University studies. Approximately 90% of the students were female.

Instruments

Beliefs questionnaire. This consisted of nine items requiring a "true" or "false" response. The nine items were primarily derived from a list of twelve statements described as "maths myths" by Kogelman and Warren (1978) in their work with students identified as suffering from mathematics anxiety. The beliefs expressed in these statements are myths in the sense that they are held without consideration of evidence (Frank, 1990). They are clearly not beliefs that are likely to result in the teaching of mathematics in a way that promotes student autonomy or a positive, dynamic view of mathematics as a discipline. For large cohorts, administration of this questionnaire takes approximately 10 minutes, including dissemination and collection.

Student Evaluation of Teaching and Learning (SETL): This questionnaire is a university sanctioned, externally administered instrument aimed at evaluating the teaching performance of University staff. It consists of 10 compulsory items with individual lecturers having the option of including up to 10 further items. Students indicate the extent of their agreement with each statement, on a 5 point Lickert scale, ranging from "Strongly Agree", corresponding to a score of 1, to "Strongly Disagree", corresponding to a score of 5.

Procedure

Students completed the beliefs questionnaire at the beginning of the first lecture of the course. The results of this initial questionnaire were not made available to students, nor

discussed with them at any stage. As the questionnaire took less than 10 minutes to administer it was only a minor interruption to the usual teaching of the unit.

The course was conducted over one semester and was delivered via a weekly lecture and 1 hour weekly tutorials. While the lecture is recognized as a non-ideal delivery method, its use was necessary given the large numbers of students involved. Although lecture notes were made available to students on the web, and attendance at lectures was not recorded, student attendance at lectures remained high throughout the semester.

Tutorials were conducted in groups of 25-30 students. Instruction in this context was interactive with students working cooperatively on activities designed to illustrate and explore information presented in the lectures. The researchers aimed to model an essentially constructivist approach to teaching in the tutorials. The content of the course included an overview of the scope of the mathematics curriculum with specific introductions to the Number, Space and Measurement strands; lesson planning in mathematics; and the nature of mathematics and its teaching and learning. In both lectures and tutorials the emphasis of teaching was on promoting an increased awareness in students of broad pedagogical ideas regarded as important by the researchers. These included the importance of teaching for conceptual understanding, the creation of rich mathematical learning environments, promoting the development of children's problem solving and thinking skills and the appropriate use of manipulatives. A further objective of the unit was to develop in students a belief in the importance of mathematics and its teaching and positive attitudes and confidence in with respect to teaching mathematics. This last objective was not addressed specifically in either the lectures or the tutorials, but rather it was hoped that this would be achieved by increasing the knowledge and skills of the students in a non-threatening environment in which they were encouraged to engage in mathematical activities.

In the final lecture, students completed the beliefs questionnaire again. They also completed a SETL with respect to each of the two lecturers who had jointly planned and delivered the course.

Results and Discussion

The percentage of students responding "true" to each of the items in the beliefs questionnaire at both the beginning and the end of the unit are shown in Table 1 along with the results reported by Frank (1990) for those items that were also included in her questionnaire. Comparison of these results with those of the pretest indicate that little has changed in the ten intervening years and supports the findings of other researchers (Bobis & Cusworth, 1995; Civil, 1993; Mayers, 1994; Wilcox et al., 1991) concerning the traditional and unhelpful nature of the beliefs that preservice teachers bring to their mathematics education courses. Item 4 alone shows a significantly lower percentage of true responses among current students. In the absence of a gender breakdown for Frank's (1990) sample, one can only speculate that this could be related to the relative proportions of males and females in the samples.

Items 1 and 7 are of particular interest in that it could logically be expected that students would respond in the same way to both. In fact, in both the pretest and posttest much greater numbers of students expressed a belief that some people have a maths mind

and others don't, than were prepared to attribute children's difficulties with mathematics to this cause. This highlights the need to consider beliefs in terms of their connections to other beliefs rather than as isolated entities (Pajares, 1992). According to Rokeach (1968) individual beliefs are part of belief systems in which some beliefs are more central, in that there are more interconnections between them and other beliefs, than others. It follows that when an apparent conflict, such as that between preservice teachers' responses to items 1 and 7, is observed a more strongly held, more central belief may be influencing the response to at least one of these items. It is possible that while the preservice teachers are happy to accept that they, and possibly other adults either have a maths mind or not, they are not prepared to attribute children's difficulties to this cause because of strongly held beliefs relating to their potential effectiveness as teachers.

Table 1
"True" Responses as a Percentage of the Total Responses for Each Item of the Beliefs Questionnaire

Beliefs about Mathematics		Frank (1990) (n=131)	Pretest (n=177)	Posttest (n=146)
1	Some people have a maths mind and some don't.	63	58	21
2	Maths requires a good memory.	44	45	25
3	There is a best way to do a maths problem.	35	44	23
4	Men are better at maths than women.	22	10	7
5	Maths is easy to teach because the answer is either right or wrong.	-	23	6
6	Mathematicians do problems quickly, in their head.	15	28	14
7	Children who have difficulty with maths naturally do not have a maths mind.	-	9	3
8	Maths requires logic not intuition.	53	57	40
9	Maths is a series of rules to be memorized and followed.	-	41	16

The posttest data show that for all items there was a marked reduction in the percentages of "true" responses in comparison to the pretest results. Many of these changes are consistent with the broad pedagogical ideas that the lecturers were attempting to convey throughout the course. Specifically, the lower rate of "true" responses to items 2, 3, 5, 6 and 10 are all consistent with a greater appreciation of such things as the importance of teaching for conceptual understanding, promoting the development of problem solving and thinking skills, and the importance of creating rich mathematical learning environments all of which, the lecturers sought to emphasise and illustrate in the course of their teaching. The fact that fewer students responded "true" to item 1 may be

indicative of an improvement in the confidence of the preservice teachers with respect to the teaching of mathematics.

While these results are encouraging it is clearly possible that students, having participated in the course, have discerned the responses that the lecturers are likely to regard favourably and are simply providing the responses they believe are wanted. From this initial study, this cohort will be followed with a view to further exploring the beliefs that they hold and monitoring any subsequent changes therein. Interviews as well as questionnaires will be used to examine their beliefs in greater depth. It may then be possible to assess the extent to which the changes observed in this study are real and lasting. Even if the extent of genuine change is considerably less than the figures obtained in this study, it could still be a very significant start in the desired direction after just the first of three mathematics education units.

Table 2 shows the average results for the two lecturers of the 14 items that were common to the SETLs that students completed with respect to each.

Table 2
Mean SETL Scores for the Two Researchers/Lecturers

Statement about teaching received in the course		Average score[a]
1	The lecturer was professional in attitude.	1.63
2	The lecturer was courteous toward students.	1.47
3	I have gained a good understanding of the field.	1.88
4	Lecture and tutorial classes were well integrated.	1.63
5	The lecturer emphasized understanding as the basis of learning.	1.80
6	The lecturer seemed well organized.	1.60
7	The lecturer presented material in an interesting way.	1.80
8	The lecturer treated students with respect.	1.60
9	The lecturer seemed to know the subject well.	1.60
10	The lecturer communicated enthusiasm for the subject.	1.70
11	The lecturer emphasized thinking rather than just memorizing.	1.80
12	The lecturer's explanations were clear.	1.80
13	The lecturer was available for consultation.	1.90
14	The lecturer helped me to improve my learning skills.	1.90

[a]*Note.* Possible range 1-5, with lower number indicating stronger agreement

While it is beyond the scope of this study to attribute any causal connection between the changes observed in students' beliefs and their perceptions of the teaching they received in the course, when considered in the context of the literature it is not unreasonable to hypothesise that there may be a link. Wood (1988), in summarizing the commonalities of projects that had proven effective in reducing mathematics anxiety in various groups, concluded that in each case the students had been well taught. He goes on to describe good

teachers as both "knowledgeable and enthusiastic" (p.13). SETL items 9 and 10 indicate that the preservice teachers involved in this study perceived their lecturers in this unit as fitting this description.

Studies of the beliefs of preservice teachers in which the subjects have engaged in reflection upon their early experiences of learning mathematics consistently report recollections of particular incidents and often involving a particular teacher (Bobis & Cusworth, 1995; Stuart & Thurlow, 1995; Webber, 1998). Bobis and Cusworth (1995) infer from the prominent role that particular teachers appear to play in the development of the beliefs that students bring to their tertiary studies, that the lecturer's role in modifying those beliefs is potentially pivotal. Wilcox et al., (1991) suggests one way in which the lecturer may achieve this when they highlight the importance of the tertiary teacher's role in establishing effective collaboration among students that allows them to construct deeper understandings of mathematics. This was certainly an aim of the lecturers involved in this study.

Many of the incidents reported in the studies above included a strong emotional response on the part of the student. It is possible to infer from this that emotions may play a significant role in changing the beliefs of preservice teachers. Such an inference is consistent with the observations of other researchers. For example, in their analysis of preservice teachers' reflective journals Raymond and Santos (1995) recognized the importance of instances of "emotional and cognitive" (p. 62) disequilibration in prompting changes in beliefs while Van Zoest et al. (1994) acknowledged the role emotions may play in inhibiting the transfer of newly acquired beliefs into practice. It is possible that the quality of relationships that lecturers establish with their students impact upon their emotional responses to their preservice courses, perhaps in ways that make them more likely to identify with and adopt the teaching behaviours being modeled. The results obtained for SETL items 1, 2, and 8 are indicative of positive lecturer-student relationships as perceived by the students in this study. Further exploration of the relationship of the role of the lecturer in influencing the beliefs of preservice teachers is certainly warranted.

Particular items from the SETL clearly relate quite closely to particular items from the Beliefs questionnaire. For example it could be expected that lecturers behaving as described in SETL item 11, might influence students' beliefs about the role of memorizing in mathematics (Beliefs items 2 and 9) in the manner that these beliefs were observed to change.

Concluding Comments

This study is the first step in an attempt to evaluate the effectiveness of an existing series of mathematics education units in modifying in positive ways, the beliefs of preservice teachers. Results indicate that significant impacts on preservice teachers beliefs may be possible without prohibitively costly modifications to existing courses and suggest that the role of the lecturer may crucial.

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