Recollections of Mathematics Education: Approaching Graduation and 5 Years Later

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As part of an evaluation of the mathematics education strand of a bachelors degree program a sample of a cohort were interviewed on completion of their mathematics education studies, and another sample from the same cohort were interviewed 5 years after graduation. Interviewees were asked about their perceptions of the value of the course and its impacts on their beliefs about teaching mathematics. Comparison of the responses revealed changes in priorities and evidence of the shifting status of memories. There are implications both for mathematics educators and for understandings of the development and structure of teachers' knowledge and belief systems.

Longitudinal studies in education typically involve preservice teachers in their final year, moving into the first or second years of their teaching careers. Levin (2003), in introducing her exceptional 15-year study, lists many examples of studies of this kind and the situation in relation in mathematics education is similar.

Short term views of course effectiveness are also typical, with evaluations of various aspects of mathematics education programs usually conducted immediately at the ends of units or courses (e.g., Beswick, 2006; Hart, 2002). The preservice teachers who provide data for such evaluations have necessarily had limited opportunities to test the ideas and experiences with which they have engaged at university. Furthermore, it is well-established that the main opportunities that preservice teachers have to apply their university learning, namely practica, have the effect of negating, at least to some extent, the changes in their beliefs about how mathematics is learned and is best taught that their studies appear to have achieved (Hart 2002; Beswick, 2006). The problem, identified by Ball (1990), of beginning teachers reverting to teaching practices that are familiar from their own experiences as students is well known. It has been linked with the firm beliefs about teaching that preservice teachers bring to their university studies (Bobis & Cusworth, 1995) and the difficulty of changing beliefs (Lerman, 1997).

This study was designed to take a longer term view of the impact of the mathematics education units in a bachelor of education (B. Ed.) (early childhood and primary) program by considering the views of teachers who had graduated 5 years earlier. The evidence cited above suggested that teaching experience may have had a significant impact, possibly eliminating the initial effects of the units. On the other hand, a longer period in the field may have afforded opportunities for the teachers to reflect more carefully on their university mathematics education units, free of the pressure of being assessed that is inherent in the practicum, and having had time to come to terms with the demands of classroom life. In either case, it was recognised as imperative that teacher education practices be based on evidence of their effectiveness. As the Committee for the Review of Teaching and Teacher Education (CRTTE, 2003) stated, "Teacher education courses need to demonstrate overall quality and effectiveness in preparing highly competent teachers. To meet diverse student requirements, they need to be flexible and responsive." (p. 119). At the same time there are ongoing calls for the adoption of standards for teaching excellence (e.g., Australian Association of Mathematics Teachers, 2006) and moves towards national accreditation of teacher education programs (Teaching Australia, 2006).

With these factors in mind, the research questions that formed the study's focus were:

1. How do graduates of a B. Ed. program perceive the mathematics education strand of their course 5 years after graduating?
2. How do these perceptions compare with those of members of the same cohort prior to graduating?

Theoretical Framework

The theoretical underpinnings of this study are based in understandings of beliefs as incorporating knowledge (Beswick, 2007), and belief systems as described by Green (1971). In this section these ideas are introduced, and elaborated to account for explanations of memory including the phenomenon of forgetting.

Beswick (2007) defined beliefs as anything that an individual regards as true, and this is the definition adopted in this study. Since constructivists maintain that our only access to reality is by way of our senses, there is no basis for establishing the absolute truth of any proposition. Nevertheless, there are understandings that are more or less common in any given society at any given time and that tend to be referred to as knowledge within that context. They are distinguished from beliefs only in being judged to be supported by better or more evidence and to have greater explanatory power in relation to perceived events in the world (Guba & Lincoln, 1989).

It is well-established that beliefs constitute systems rather than existing as isolated entities. Of particular relevance to this study is Green's (1971) notion of the centrality of beliefs. The more central a belief the more intensely it is held as a result of its greater connection to other beliefs, and hence the more difficult it is to change. However, belief systems are also dynamic and beliefs are contextual. The particular beliefs that are most centrally held vary according to the context and this fact can explain apparent contradictions between beliefs professed in one context with those inferred from observations in another (Beswick, 2003). Remembering that beliefs and knowledge are equivalent from a constructivist viewpoint, knowledge that is less relevant in a particular context is less central. That is, it is less well connected with other knowledge. Knowledge that remains peripheral in this way would become increasingly less central by the further loss of connections and at some point could be described as forgotten. Such a view is consistent with the well known fact that the ability accurately to remember, declines with time but that such loss of memory is reduced by review (Basden, Reysen, & Basden, 2002). In terms of belief/knowledge systems, review amounts to bringing knowledge to a place of centrality thereby strengthening its connections within the system.

Beswick (2004) argued that an individual's beliefs about themselves are likely to be among his/her most central. They are also likely to maintain their centrality across a broad range of contexts and hence to be powerful drivers of behaviour in many circumstances. Beswick (2004) used the particular centrality of beliefs about self to explain the intransigence of the beliefs and practice of one mathematics teacher, and Wilson and Demetriou (2007) pointed to the special importance of teacher's identity at the beginnings of their careers. Connections between memory and emotion are likely to be related to the centrality of beliefs about self. For example, Mather and Johnson (2003) found that when subjects reviewed their affective responses to an observed event their ability accurately to recall its details at a later time was impaired, but there was an increased tendency to articulate false memories that were in line with their existing beliefs. Focussing on one's own emotional responses when reviewing an event creates a context in which one's most centrally held beliefs (i.e., those about oneself) are likely to be connected with memories of the event, thereby incorporating these memories inextricably with existing central beliefs. Sfard and Prusak's (2005) equating of identity with stories about the individual concerned highlights the largely social nature of identity and helps to explain the fact that memory is strongly influenced by the recollections of others and that false memories introduced through social interaction are sustained (Basden et al., 2002). In Sfard and Prusak's terms, beliefs about self amount to that part of identity which is the stories that one tells oneself about oneself.

The Study

The study was conducted as part of an evaluation of the mathematics education strand of the B. Ed. at the University of Tasmania. At the time that the participants were enrolled, the strand comprised three half-units of mathematics education offered in years 2-4 of the program. The first two involved weekly 1-hour lectures, and 1-hour tutorials designed to exemplify the lecture content, throughout a 13-week semester. The final component was taught as weekly 2-hour tutorials for a semester. In all cases tutorial numbers were approximately 25 and tutorial activities involved considerable group work on relevant mathematics, and use of manipulatives. In addition to these compulsory units, students could elect to study up to three mathematics education elective modules each comprising a series of six 2-hour tutorials. The three were entitled: *Investigations in Space and Number*, *Problem-solving in Maths*, and *Maths for Middle School*. Almost all students in the cohort elected to do at least one of these and many chose two. This was the

first cohort for whom the mathematics education components were the same for all students, regardless of their specialisation (early childhood (K-2), or Primary (3-6)). Each component was designed to integrate mathematical content and pedagogy and, in tutorials, the lecturers endeavoured to model teaching that was consistent with a constructivist view of learning.

Participants. The 15 students interviewed in 2001 reflected the gender proportions of the cohort in that two were males. In 2006/07 one of the eight teachers interviewed was working in a child care centre, and the remainder were employed in government schools. Two were male. Four (three women and one man) had been members of the 2001 sample.

Interviews. The audio-taped interviews in both 2001 and 2006/07 were of 30-60 minutes duration. The questions relevant to this study asked participants to: nominate two things that they liked about the mathematics education strand of their course and two things that they did not like; and describe ways in which they felt the course had impacted their beliefs about the nature of mathematics, mathematics teaching, and mathematics learning. In 2006/07 participants were also asked about their current employment, their specialisation (early childhood or primary), the number and placement in the course of mathematics components, and to describe if and how they had used ideas from the course.

Procedure. In 2001 every ninth student on an alphabetical list of the 141 students enrolled in the final mathematics education component of the program was invited to be interviewed. The next student on the list was invited in cases where the initially invited student declined. In 2006/07 as many of the 2001 sample as could be located were invited to participate and then, using the same list as in 2001, attempts were made to locate successive students following each 2001 participant. The University's student administration mailed invitations to those who could not be located on the publicly accessible government database. Difficulties resulting from out-dated addresses at student administration, name changes, and the fact that many graduates do not find employment in Tasmanian government schools limited the size of this sample.

Interviews in 2001 were conducted immediately following the final mathematics education component of the B. Ed. program, and again in the period from the end of 2006 to early 2007. Several of the 2006/07 interviews were conducted by telephone.

Results and Discussion

Table 1 provides data about the 2006/07 participants' employment, specialisation, and recollections of the number and placement of mathematics components in their course. Only two, Susan and Stuart, correctly recalled the structure of the mathematics strand, and five held positions that did not correspond to their specialisation. The latter fact vindicated the decision that had already been made to ensure that all students studied mathematics education covering the range K-6.

Table 1

Personal data and recollections of the 2006/07 sample

Pseudonym	Number of mathematics education components studied	Where in the course were the maths ed. components?	Current position	B. Ed. Specialisation
*Susan	3 + Maths for middle school	Years 2-4	Teacher Learning Support Leader, K-10, for cluster of schools	Primary
*#Eve	All compulsory units + early childhood maths in year 4	Years 1-4	Teacher, grade 3/4	Early childhood
*#Ewan	Maths for middle school + something else	Year 3	Teacher, grade 9-12 mathematics	Primary
*Clare	8, 1 per semester	Years 1-4	Child carer, K & pre-K	Early childhood
Emily	Core units + maths for middle school	Years 1-4	Teacher, grade 5/6	Primary
#Laura	4	Years 1-4	Teacher, grade 9/10, not maths	Early childhood
#Mandy	Can't remember	Can't remember	Teacher, grade 10, not maths	Primary
#Stuart	3 + a couple of extras	Years 2-4	Teacher, grades 8-10 including maths	Primary

* Also a 2001 participant # current position does not match specialisation

Responses to the question about likes and dislikes in relation to the mathematics strand were coded and categorised as shown in Table 2. The table includes examples of responses in each category and shows the numbers and percentages of responses in each in both 2001 and 2006/07. On both occasions participants most commonly referred to liking the teaching staff, course content, or the nature of activities, however over time it appears that positive recollections of staff became relatively more common while references to liking aspects of content declined. Indeed, content was the most commonly used category of dislike in the follow up interviews. In 2001 dislikes most commonly related to assessment but this was a less prominent concern in the later interviews. The time allocated to mathematics education was not mentioned in 2006/07.

Table 2

Likes and dislikes about the mathematics education strand

		Likes		Dislikes		Likes & dislikes	
Category	**Example(s): like, dislike**	**No. 2001 (%)**	**No. 06/07 (%)**	**No. 2001 (%)**	**No. 06/07 (%)**	**No. 2001 (%)**	**No. 06/07 (%)**
Staff	approachable, this year's tutor	6 (13)	6 (29)	1 (7)	0 (0)	7 (11)	6 (21)
Content	activities you could use in the classroom, 1st year not primary focussed	22 (46)	5 (24)	3 (20)	4 (50)	25 (40)	9 (31)
Nature of activities / delivery mode	Working on tasks as groups, would have liked lectures in 4th year	14 (29)	7 (33)	1 (7)	2 (25)	16 (25)	9 (31)
Assessment	Lesson plan assignments, that we had to do assignments	5 (10)	0 (0)	6 (40)	2 (25)	10 (16)	2 (7)
Time allocation	Should be in 1st year too, 2-hour tutes a bit tiring	0 (0)	0 (0)	4 (27)	0 (0)	4 (6)	0 (0)
Other	I just like maths	1 (2)	3 (14)	0 (0)	0 (0)	1 (2)	3 (10)
Totals		48	21	15	8	63	29

The nature of positive comments about staff were similar on both occasions and included references to the lecturers "relating to us like people", using humour, being enthusiastic and passionate about mathematics, and not being patronising or intimidating. Many of these were emotionally laden in that they related to the participants' own feelings as they engaged in the course. Several comments were indicative of course contributing to participant's identities in relation to mathematics. For example,

> At school I was labelled and pigeonholed as brilliant at English and all that and just vegie maths … so when I got to Uni and had to do maths I was really, really nervous and (Maths Ed. lecturer name) made us draw something in the first lesson about what we feel about maths and I drew someone with their mouth open and scared. So it's changed my whole perspective and it has also made me feel fantastic about teaching maths. (2001)

It is not surprising that such emotionally focussed, and central (in that they relate to self) recollections were retained.

Criticisms of course content in 2006/07 included "not learning all about the content (of the Tasmanian curriculum)" (Eve), that the course "didn't always cover how to introduce something for the very first time" (Emily), provided, "nothing to help with teaching high school" (Laura), and that "more 7/8 and less early childhood would have helped" (Mandy). As shown in Table 1, Laura and Mandy were both teaching in secondary schools.

Responses to being asked about the impact of the course on their beliefs are categorised in Table 3. All of 60 statements made in 2001 described changes in beliefs attributed to the course and all were in line with the aims of the course. However, in 2006/07, four of the 36 statements described the course in terms of building on or confirming existing beliefs. Three of these statements were made by Susan (see Table 1). Comparison of her perceptions of the impact of the course on her beliefs in 2001 and 2006/07 suggests that, with time, the novelty of new ideas had faded to the extent that they were perceived as having been always there. In 2001 Susan said,

> I used to … think maths was purely memorising, like you'd just memorise all these formulae … Whereas now I think of it more as problem solving and more patterning.

In 2006/07 she said,

> Through doing college maths (year 11/12) I'd started to develop that understanding of maths as being patterns and it really built on that I'd say, just confirmed that maths was enjoyable and also helped me further explore the pattern based maths.

Susan's view of mathematics as patterning had become so enmeshed with her other beliefs about mathematics and mathematics teaching and learning that when asked to reflect on the impact of the course she could not disentangle ideas originating there from others.

Table 3

Perceived impacts on beliefs

Category	Example(s)	No. 2001 (%)	No. 06/07 (%)
Importance of maths	I can see the importance of it more	1 (2)	1 (3)
Multiple methods	There are different ways to get to the same end point	2 (3)	2 (5)
Enjoyment	It doesn't have to be boring; Maths teaching can be enjoyable	6 (10)	3 (8)
Student diversity	Students are very different; I teach children not grades	4 (7)	7 (18)
Applications, relevance, hand-on tasks	I think statistics and percentages are useful but you don't do algebra everyday; children learn via real life experiences	11 (18)	6 (17)
Conceptual understanding, problem solving	I've looked more deeply into the thinking aspect of maths; maths teaching should be about developing conceptual understanding	9 (15)	7 (19)
Memorisation, repetition, text books, intelligence	I used to think maths was about right and wrong answers; used to think you just use text books and chalk	10 (17)	3 (8)
Confidence, competence	More confident now; I feel fantastic about teaching maths	7 (12)	1 (3)
Comparison with own experience	It doesn't have to be taught the way it was taught to me	3 (5)	1 (3)
Teacher	Teacher enthusiasm is important	1 (2)	0 (0)
Other	I had negative beliefs because of experiences at high school; my previous beliefs were completely wrong	6 (10)	5 (15)
Totals		60	36

In 2006/07 there were also two critical responses, both related to student diversity which was one category for which the number of responses increased between the two sets of interviews. The two statements were, "... hasn't helped me understand how children think about maths" (Laura), and "there wasn't much about how to deal with that (differences between students)" (Stuart). In its 2007 survey of beginning teachers, the Australian Education Union (AEU) found that 69.1% of respondents believed that preservice teacher education had not adequately prepared them to teach diverse groups of students but this issue did not feature among their most commonly held concerns. Instead, workload, pay, behaviour management, and class sizes were of highest priority (AEU, 2008). This is in line with the preoccupation of preservice and beginning teachers with behaviour management evident in the research literature (Bobis, 2007). The concern for professional learning expressed by 31.7 % of respondents (AEU, 2008) may or may not have included a perceived need for professional learning related to catering for student diversity, and caution is needed in comparing these data with the responses of just eight teachers interviewed in the current study in 2006/07. However, it seems that, for these teachers, after 5 years of experience, behaviour management may have subsided as an issue to be replaced with a heightened concern about how to teach individual students. If this is the case then it may be that after the beginning phase teachers are able to revisit ideas encountered at university.

The 2006/07 interviews provided some evidence that this might be the case. Five of the eight interviewees reported having used and found helpful, ideas that they learned at university. In contrast to this, Eve said she had tried some ideas in her first year but they'd not "worked". Eve and Laura were the only teachers who had discarded all of their university notes and materials, and Mandy had not had the opportunity to teach mathematics but still had "some things". It was evident that some had simply used various activities and tasks but some also provided encouraging indications of having taken deeper lessons with them. Examples included the following:

> When I was a beginning teacher, whenever I was introducing a new topic … I'd go back to the notes and remind myself of what the key concepts were that I should be focussing on developing … use some ideas from the tute notes that I thought were relevant to the groups I was working with and build on those. (Susan)

> All you want to do when you are at university is go out and teach and you really are not so enthused about the theoretical aspects of it, but then as you become a teacher you realise that you need all that theoretical stuff actually, you know, it's got to be in the back of your mind when you're actually teaching and planning and assessing kids. (Emily)

> I actually get the kids to use a lot of reflective journal writing these days because I find that that actually tells me more about what they understand and what they don't understand, about their mathematical thinking … (Emily)

> I can see the value in a lot of the activities I'm doing that maybe I couldn't have unpacked before. (Clare)

> A lot of water has passed under the bridge since then. I can remember (Maths Ed. lecturer name) saying that the process was extremely important and I found out since that she was 100% correct. (Ewan)

Conclusion

Overall the mathematics education strand of the B. Ed. course was perceived positively by this cohort, both immediately at its completion and 5 years later, and it appears to have had a lasting impact on the thinking of at least some of them. It was possible to reconcile relevant findings about memory with Green's (1971) description of beliefs systems, accompanied by a broad definition of beliefs, and this was useful in explaining the kinds of things that were more likely to be remembered. Essentially, knowledge that becomes central in the sense of having many connections with other beliefs, and particularly to those about self, is most likely to be retained. This includes knowledge that has an emotional meaning to the individual concerned and that constitutes part of his/her identity. There was also evidence that such knowledge becomes so entangled with existing knowledge that its source is lost. Although this is not a concern in terms of improving mathematics teaching, it is probably not helpful in developing positive views of preservice teacher education in the wider community. Furthermore, although not evident from this study, Basden et al.'s (2002) finding concerning the social transmission of distorted recollections suggests that participation in a community, such as a school, where inaccurate memories of teacher education (which were noted in this study) are likely to be shared, could lead to such beliefs becoming widely held.

Only a small sample of the cohort was interviewed in 2006/07 and the selection process militated against the inclusion of graduates working outside of Tasmania, in Catholic or independent schools, or not working at all. Although many encouraging comments were made it was not possible to observe teaching and thereby gain further insight into what the various comments meant. Nevertheless, this study has provided a rare long term evaluation of a primary mathematics teacher education program and offers some encouragement that the preoccupations of beginning teachers may give way to a focus on more substantive issues of practice for at least some teachers. Further research of this nature is needed, including studies in which data collection includes classroom observations and is continuous over many years.

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