TEACHER AND PRESERVICE TEACHER BELIEFS ABOUT MATHEMATICS TEACHER EDUCATION

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This paper reports on the perceptions of mathematics education of in-service and preservice primary school teachers involved in an innovative model trialled in the final mathematics curriculum unit of a B.Ed. program. Questionnaire items asked about the value of time spent in classrooms, the importance of theoretical understandings, and of linkages between theory and practice. Both groups reported valuing time in schools, understanding the theories that underpin practice, and lecturers with recent classroom experience, but there were also interesting differences between the groups at the beginning and at the end of the unit, and some change for each group.

Introduction

Concerns about best practice and pedagogy for mathematics teacher education and the perceived theory-practice divide have been raised by researchers, teacher educators, school educators, and the public (Kolthargen, Loughran, & Russell, 2006). There is a perceived gulf between the pedagogies that preservice teachers are introduced to and encouraged to adopt through their education courses, and the practices they encounter in classrooms (Kolthargen et al., 2006; Taylor, 2002). Preservice teachers report dissatisfaction with what they have learned in their teacher education programs (Australian Secondary Principals' Association, 2007) considering some of it irrelevant (Kolthagen, 2010; Shuck, 1996). Consistent with this, there is evidence that they consider the most valuable aspects of their university courses to be those which have the most apparent relationship to classroom practice (Beswick, 2006; Shuck, 1996). Klein (2006, p. 335) suggested that "preservice teachers' ways of being a teacher of mathematics has less to do with theory and policy than their previous (and current) experiences of institutionalised teaching and learning."

The study reported here was designed to examine the potential, in terms of closing the theory-practice divide, of closely linking university learning experiences with classroom practice in the context of the final mathematics curriculum unit of a primary (Grades 3-6) and early childhood (Grades K-2) Bachelor of Education program. The specific research questions addressed were;

1. To what extent do preservice and practising teachers share beliefs about mathematics teacher education?

2. How might these beliefs be influenced by a mathematics curriculum designed to link university and school contexts?

Relevant literature related to nature and origins of the perceived gap and to influencing belief systems is reviewed in the sections that follow.

Bridging the gap

What preservice teachers view in schools during their practicums has a profound effect on their view of what is best practice in mathematics teaching (Beswick, 2006; Kolthagen, 2010; Shuck, 1996) and often this reinforces preconceived ideas of teaching pedagogy which were formed during their own schooling, and that are contrary to understandings that their teacher education courses are designed to develop (Beswick, 2006, Klein, 2006). Consistent with this, Calderhead and Robson (1991) found that preservice teachers' experiences and beliefs held from their own education influenced the pedagogy they used in classroom teaching and their ability to make the transition to new ideas presented to them. Kolthagen et al. (2006) suggested that programs need to focus on the preservice teacher as a learner, able to reflect on experiences and practice and to be able to analyse and make meaning from them.

The perception of a theory-practice divide is shared by many practising teachers and may be linked to distorted recollections. The ability to recall events accurately naturally declines over time (Basden, Reysen, & Basden, 2002). This fact and the propensity for people to form false memories, perhaps influenced by recollections of others shared and reinforced in social contexts such as school settings, can result in a lack of realisation by teachers that many of the practices they use are in fact linked to their university teacher education courses (Basden et al., 2002; Beswick & Dole, 2008).

Allen, Butler-Mader, and Smith (2010) argued that the theory-practice gap can be bridged by forging university school partnerships. Their study involved the recruitment of practising teachers as secondees and sessional tutors to a university as part of a university school partnership. Such an approach was supported by Nelson (2005, cited in Allen et al., 2010 p. 623), in his role as Australian Minister for Education, who commented that, "Many who train teachers do not see themselves as members of the teaching profession itself. Perhaps we need more teachers in universities with teaching appointments". However, according to Allen et al. (2010, p. 622), school personnel working in universities still "saw the work as separate and distinct from their work in schools" and the study identified the need for ongoing communication and the sharing of ideas between the university and the schools involved.

An important role of mathematics educators is to influence preservice teachers to teach differently from the ways in which they were taught (Goos, 2009). Because preservice teachers value lecturers who are enthusiastic and passionate about mathematics, and know their subject (Beswick & Dole, 2008; Hill, Lomas, and McGregor, 2003), the credibility of lecturers and tutors themselves may have an impact on helping preservice teachers to embrace new ideas. In fact Hill et al. (2003) found that the quality of lecturers was one of the two most influential factors in determining the quality of a preservice teacher education program, and that this was influenced by the lecturer's expertise in school classroom contexts. Programs such as that which formed the context of this study have the potential to strengthen lecturers' knowledge of school classrooms and build their connections with the contexts that preservice teachers value,

thereby enhancing their credibility and influence and hence the value attached to university aspects of mathematics teacher education.

Beliefs systems and change

A further aspect of the theoretical underpinnings of the study lies in understandings of beliefs and the conditions under which they are most likely to change. Beliefs are understood as anything that a person regards as true (Beswick, 2007) and, consistent with a constructivist view, as distinguishable from knowledge only in terms of the degree of consensus that they attract (Beswick, 2011; Guba & Lincoln, 1989). Greens' (1971) widely accepted description of belief systems in which beliefs are characterised by varying degrees of centrality (a function of the number and intensity of connections with other beliefs), and subject to clustering, whereby parts of an individual's belief system can be held in isolation from other beliefs, is foundational. Belief systems are also dynamic with the relative centrality and influence of beliefs shifting according to the context (Beswick, 2003).

Clustering can result when beliefs arise in differing contexts. For example, beliefs about teaching that originate in an individual's experience of teaching as a school student and beliefs about teaching that are formed in the context of university based teacher education may be held in distinct clusters. Belief clustering provides an explanation for the ability of teachers to endorse the aims of teacher education programs whilst simultaneously agreeing with apparently contrary practices in a school context.

Together belief clustering and the dynamic nature of their interconnections explain why preservice teachers so often revert to teaching in the ways that they were taught (Ball, 1990). Classroom contexts evoke beliefs formed in similar contexts as students, and these may not have been reconciled with contradictory beliefs formed subsequently. It is these classroom connected beliefs that exert the dominant influence on practice in that context. Awareness of a disjunction between beliefs about teaching that underpin practice and those that are promoted in teacher education programs may lead teachers to rationalise the difference by rejecting those perceived as less relevant and adopting the notion of a theory-practice divide. Bridging the gap can therefore entail substantial and onerous intellectual work and requires that teachers have the opportunity, time and support to work through the process to arrive at an integrated system of beliefs about teaching and hence more balanced views of the benefits of the university and school based aspects of their courses. Experiences that closely link university and school based learning might provide such an opportunity.

The study

Consistent with the literature, the project that formed the context of this study was embedded in a partnership between schools and a university in which connections and communication were forged. Importantly, the partnership was initiated by a school principal who saw mutual benefits for school and preservice teachers. Opportunities were provided for students to apply their theoretical understandings and knowledge of mathematics teaching to a classroom situation in partnership with classroom teachers and university personnel. In this way preservice teachers and the practising teachers who acted as their mentors were assisted to marry new ideas with their own.

The final mathematics curriculum component of the B.Ed. (Primary and Early childhood) program in within which the study was conducted aimed to bring together aspects of the preservice teachers' knowledge described by Shulman (1987), namely their knowledge of mathematics content, general pedagogy, mathematics curricula, students as learners of mathematics, and pedagogical content knowledge for mathematics teaching, applying them to the classroom context. The previous units in the mathematics curriculum sequence had been half-units comprising weekly 1-hour lectures and 1-hour tutorials over a 13-week semester. The students had also had the opportunity to study some mathematics education elective modules.

Participants

Ninety six of the 106 preservice teachers enrolled in the fourth and final half unit of mathematics curriculum in the B. Ed (early childhood and primary) course at the University of Tasmania participated in the study, along with 32 teachers (referred to as mentor teachers) and school leaders from three primary schools. The preservice teachers who chose not to participate in the study were involved in the unit in exactly the same ways as those who did but simply opted not to submit data.

One of the schools involved was a small (enrolment of approximately 160) city school in a socio-economically disadvantaged area and the other two schools had approximate enrolments of 260 and 380 and were in moderately socio-economically disadvantaged areas. The smaller of these schools was an outer city suburb with an intake from some country areas as well as adjoining suburbs. The other was an inner suburban school in a smaller regional city.

Questionnaires

Data were collected in a range of ways including interviews, field notes, and classroom observations but only the questionnaire data are relevant to the current study. Participating mentor teachers, principals and preservice teachers were invited to complete pre- and post- questionnaires. The initial questionnaires were identical for all groups and comprised six sections that asked about: (1) expectations of the project; (2) confidence to teach mathematics; (3) beliefs about mathematics and numeracy in everyday life; (4) beliefs about mathematics in the classroom; (5) beliefs about mathematics teacher education; and (6) the respondent's role, gender, school or campus. Sections 2, 3, 4, and 5 comprised items requiring responses on 5-point Likert types scales such that 5 represented the highest level of agreement or confidence and 1 the lowest. Section 5 on Mathematics teacher education is relevant to the current study and its 16 items are listed in Table 1.

The final preservice teacher questionnaire repeated all of the sections from the initial questionnaire that required responses on Likert type scales whereas the final teacher questionnaire (also completed by principals) repeated only the section on mathematics teacher education. Both final questionnaires contained additional open-response items focussed on evaluation of the unit. In all cases responses were anonymous with respondent devised codes used to match responses across the two surveys.

Procedure

Prior to the start of the unit the preservice teachers were randomly placed in groups of four with a mentor teacher from one of the three schools involved in the project. This

meant that students may not have been working in their chosen specialisation (early childhood (Grades K-2) or primary (Grades 3-6)). This was appropriate because the degree towards which the preservice teachers were working qualified them to teach from K-6. The randomised allocation to groups was also designed to mirror the realities of working with unfamiliar colleagues in school settings.

The initial questionnaires were distributed and completed in meetings that involved preservice teachers and mentor teachers on each of the two campuses where the program ran. The main purpose of these meetings was to introduce the unit structure and provide opportunities for the principals to address the preservice teacher cohorts and for initial meetings of preservice and mentor teachers to occur.

Mentor teachers identified the school students with whom the preservice teacher groups would work, and the first 6 weeks of the semester were used for collaborative planning by preservice and mentor teachers, administration of agreed pre-assessment tasks to the small groups of students with whom the preservice teachers would be working and for preservice teachers to become familiar with the classroom environment and particular students to which they had been assigned. Preservice teachers also attended mathematics education workshop/tutorials at the university. These 2-hour sessions focused on assessing and planning models, mathematics curricula, creating a positive classroom climate, use of ICT, and the mathematics knowledge required for teaching. Individual groups met with their university lecturers for further pedagogical and content support as they were planning and designing assessment tasks and analysing student responses to these.

In the following weeks the preservice teachers worked in the schools for six weekly sessions and had ongoing meetings with their mentor teachers. University staff maintained contact with the preservice teachers and school personnel and visited the schools several times. At the end of the semester the preservice teachers, teachers and school leaders participated in a meeting and celebratory afternoon tea to share experiences and highlights of the project. The final questionnaires were administered at these sessions.

Assessment of the unit was entirely separate from the research and required preservice teachers to submit reflective journals detailing their learning from the experience and philosophical statements relating to their beliefs about mathematics teaching and learning. Pre- and post-project comparisons of questionnaire responses were made using *t*-tests and effect sizes, *d*, calculated as described by Burns (2000).

Results and discussion

Table 1 shows the means and standard deviations for the teacher and preservice teacher responses to each of the 16 items about mathematics teacher education on the initial and final questionnaires. There were many fewer responses to the final questionnaire, particularly from preservice teachers. This reflects the much lower attendance at the final meeting as a result of the competing priorities for preservice teachers' time at the ends of semesters.

Table 1. Teachers' and preservice teachers' beliefs about mathematics teacher education.

Item	Teachers				Preservice teachers			
	Initial mean	Initial SD	Final mean	Final SD	Initial mean	Initial SD	Final mean	Final SD
	(n=32)		*(n=20)*		*(n=96)*		*(n=27)*	
1. The more time preservice teachers spend in schools and classrooms the better.	4.77	0.43	4.75	0.44	4.62	0.63	4.63	0.63
2. It is important to understand the theories on which teaching practices are based.	4.20	0.71	4.35	0.59	4.24	0.75	4.27	0.67
3. All aspects of teaching can be learned in schools and classrooms.	2.93	1.02	3.10	0.97	3.20	1.16	3.23	1.14
4. What is taught at university about maths teaching is useful in the classroom.	**3.47**	0.78	**4.05**	0.51	3.71	0.74	4.00	0.69
5. The classroom teacher is the most important influence on school students' mathematics learning.	3.60	0.81	3.80	0.89	3.88	0.75	3.84	0.85
6. All aspects of teaching can be learned at university.	1.80	0.81	1.60	0.75	1.98	1.03	1.85	1.12
7. Working with individual students is a useful part of teacher education.	**4.10**	0.80	**4.55**	0.61	4.20	0.71	4.48	0.65
8. Teachers can easily describe the reasons for their teaching decisions.	3.70	0.79	**4.00**	0.86	3.45	0.77	**3.19**	0.85
9. Regular time in school classrooms throughout the semester is more effective than blocks of time.	3.97	0.81	3.85	0.93	3.88	0.90	4.04	0.87
10. The university teacher is an important influence on preservice teachers' learning about mathematics teaching.	3.83	0.75	4.10	0.64	4.04	0.75	3.88	0.82
11. It is important that teachers can articulate the theory that informs their teaching decisions.	3.90	0.80	4.20	0.70	3.96	0.75	4.12	0.77
12. I can see connections between what I have learned about teaching maths at university and working in school settings.	3.55	1.15	**3.65**	0.67	3.93	0.70	**4.12**	0.77
13. It is important that lecturers have recent classroom teaching experience.	4.37	0.67	4.50	0.61	**4.33**	0.72	**4.77**	0.43
14. Spending time in schools and classrooms is not necessarily beneficial.	**1.77**	0.73	***1.30***	0.57	1.83	1.10	*2.23*	1.42
15. University and school based learning experiences are equally important.	3.63	0.89	3.80	0.83	3.73	0.86	3.69	1.09
16. Analysing the work of individual students can provide important insights into mathematics teaching.	4.23	0.82	4.50	0.51	4.19	0.67	4.23	0.65

On average, the preservice teachers and their mentor teachers agreed at both the start and end of the project with Items 1, 2, 7, 13, and 16. These concerned the value for preservice teachers of spending time in classrooms, working with individual students, and analysing students' work, as well as the importance of understanding the theoretical bases of teaching practices, and having lecturers with recent classroom experience. Both groups of participants at both survey administrations disagreed on average with statements that "All aspects of teaching can be learned at university" (Item 6) and that, "Spending time in schools and classrooms is not necessarily beneficial" (Item 14). Although consistent with the literature documenting preservice teachers' valuing of classroom based learning (Beswick, 2006; Schuck, 1996), these results suggest that both preservice and inservice teachers also regard theoretical understandings of their work as important.

Pairs of significantly different means are in bold or, in the case of Item 14 for which there was a significant difference between the initial and final means of the teachers' responses, and also between the final mean for teachers and the final mean for preservice teachers, one significantly different pair is bold and the other italicised. There were no significant differences between the overall views of the preservice teachers and their mentor teachers at the start of the semester, but there were differences for three items at the end. Preservice teachers finished the unit less inclined than their mentor teachers to agree that teachers can easily give reasons for their teaching decisions (Item 8, $t(44)=3.18$, $p=0.003$, $d=0.94$) and more likely to agree that they could see connections between their university learning about mathematics teaching and their work in school settings (Item 12, $t(44)=-2.06$, $p=0.046$, $d=0.54$). Their disagreement with Item 14, that time in schools is not necessarily beneficial, was on average less strong than their mentor teachers' at the end of the semester ($t(44)=-2.75$, $p=0.009$, $d=0.65$). In each case the effect sizes were moderate to large (Burns, 2000).

The direction of change of the means for Item 8 for mentor teachers and preservice teacher indicate that the difference between their responses at the end of project resulted from a combination of the changed levels of agreement of the two groups. Increased agreement on the part of the mentor teachers that they could articulate reasons for their teaching decisions, perhaps as a consequence of needing to do so in their work with the preservice teachers, made a contribution. In addition, preservice teachers adopting a more critical stance in relation to teachers' knowledge and decision making also contributed to the significant difference for Item 8. Both changes can be regarded as positive outcomes of the approach. There is also evidence from Item 12 that the project assisted preservice teachers to connect their learning in the two contexts. The difference for Item 14 is a consequence of stronger disagreement on the part of mentor teachers and weaker disagreement on the part of preservice teachers that time in schools is not necessarily beneficial. This suggests that the mentor teachers may on average have viewed preservice teachers' involvement in their classrooms more positively than the preservice teachers themselves did.

The mentor teachers' views differed from the start to the end of semester for three items. They were more inclined at the end to agree that both university learning about mathematics teaching (Item 4, $t(48.0)=-3.21$, $p=0.002$, $d=0.75$), and work with individual students were valuable (Item 7, $t(48)=-2.13$, $p=0.038$, $d=0.56$). They disagreed more strongly than before that time in schools was not necessarily valuable

(Item 14, $t(46.6)=2.53$, $p=0.015$, $d=0.64$). The project thus appears to have influenced mentor teachers to value university learning more highly while at the same time reinforcing the value they attach to preservice teachers spending time in schools. The only change for preservice teachers was towards stronger agreement that their lecturers should have recent classroom experience (Item 13, $t(69.1)=-3.85$, $p=0.000$, $d=0.61$). Given the other changes noted this difference may reflect the preservice teachers' appreciation of the way that their lecturers were able to work with the schools and to mediate their involvement in the school context. Although beyond the scope of this project it is possible that, consistent with Hill et al.'s (2003) reasoning, the lecturers' ability to perform this role enhanced their status and influence with the preservice teachers.

Conclusion

In terms of the research questions, this study provides evidence that inservice and preservice teachers share similar beliefs about mathematics education. School placements are therefore likely to reinforce preservice teachers' beliefs in the value of classroom experience in learning to teach (Beswick, 2006; Schuck, 1996). However, the data also show the potential of integrated school and university programs such as that described here have the potential to influence the beliefs of both inservice and preservice teachers towards a more balanced view of the worth of university and classroom based learning.

The data suggest that inservice and preservice teachers ended the program valuing both classroom practice and the theories on which it is based. There was a significant increase in beliefs that what is taught at university is useful in classrooms. This suggests that working with university courses and preservice teachers may help practising teachers to see the connection between theory and practice and may counteract some of their distorted recollections of their own teacher education courses (Basden et al., 2002; Beswick & Dole, 2008). The study also suggests that strong links made between university courses and practice, and strong communication pathways between school personnel, university lecturers and preservice teachers as in this study may assist preservice teachers to make connections between their learning in the two contexts.

Preservice and inservice teachers agreed that working with individual students can provide important insights into mathematics teaching. There is likely, therefore, to be value in strengthening this element of preservice mathematics education courses even in more traditional contexts where work samples and video excerpts can be used.

The study also raises questions about the implications of preservice teachers' valuing of lecturers with recent classroom experience. Specifically, what qualities of these lecturers are considered important by preservice teachers? And to what extent does the status that experience affords them affect their ability to influence students' beliefs?

Although ideas from the beliefs literature constituted part of the theoretical framework of the program and have explanatory power in terms of teachers' practices, little is understood of the ways in which particular beliefs interact and are influenced by the myriad factors involved in learning to teach mathematics. There is a need for fine-grained in-depth studies using mixed methods to chart the changes in individual's beliefs, including about mathematics education, and the factors that trigger them.

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