A Learning Community for Pre-service Secondary Mathematics: Learning With and From Each Other

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This paper reports the impact of a collaborative professional experience model on pre-service secondary mathematics teachers' perspectives and practices within a learning community. Nine pre-service teachers made 12 school visits over one year to observe and co-teach problem-solving lessons in two Year 8 classes. They discussed the lesson with the teacher and the university supervisor, and posted reflective comments to an online forum. Data from questionnaires, interviews, and reflections indicate participation in the learning community helped pre-service teachers link theory and practice, learn from each other, and become more reflective.

Many pre-service teachers come to university with firm beliefs about learning and teaching (Scherrf & Singer, 2012) and they invariably want to teach as they were taught (Cooney, Shealy, & Arvold, 1998). This is particularly the case for secondary mathematics because pre-service teachers typically learned mathematics in a traditional manner (Cooney & Weigel, 2003). The situation is exacerbated because, rather than challenge prior understandings, some teacher education programs have been found to reinforce them (Zeichner, 2010). These courses "do not provoke students to confront their naïve notions of teaching mathematics" (Lerman, 2001, p.48) by supporting a 'cycle of tradition' (Frid & Sparrow, 2009). The quality of professional experience supervision can be inconsistent and has traditionally been *evaluative* rather than *educative* (Blanton, Berenson, & Norwood, 2001) with an over-emphasis on classroom management and organisation. Hence there is limited support for pre-service teachers to "explore, discuss, and reflect on their developing understandings" (Sim, 2006, p. 78).

In contrast, effective professional experience programs enable student teachers to learn *in* and *from* practice (Ball & Cohen, 1999). They expose student teachers to the complex nature of the classroom (Goos, 2008) and provide opportunities to implement alternative approaches (Leiken, 2008), discuss their experiences, and learn from each other (Mewborn, 2000). However, a recent report found there was "little consensus on the best structure for practicum" (Commonwealth of Australia, 2007, p. 67) and called for the development of new professional experience models that are "flexible and encourage innovation" (p. 74). Zeichner (2010) also recently noted that there were few research studies on the impact of new models of professional experience programs. The present paper seeks to address this gap in the literature by reporting the impact of a professional experience learning community for pre-service secondary mathematics teachers.

Theoretical Framework

Ponte et al. (2009) develop the notion of a *learning community* as a group of people "involved in some kind of activity that learn together and, more importantly, learn from each other" (p. 197). The authors describe four key issues for a learning community: (i) the purpose of the group and how closely the members identify with that purpose; (ii) the knowledge that develops from the activity of the group; (iii) how learning happens in the group; and (iv) the roles and relationships of group members, especially their mutual involvement and commitment to the group's progress.

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In this learning community, the purpose for the pre-service teachers was to develop their professional practice through observation and co-teaching (Bobis, 2007), and reflection on practice through group discussion (Sim, 2006) and individual reflections (Ebby, 2000). The learning community encouraged the mutual involvement of participants through *reciprocity* or "the development within learning communities of learners' commitment to and responsibility for their own learning as well as that of other members of the community" (Le Cornu & Ewing, 2008, p. 1808). Reciprocity requires a shift in focus from the individual to a shared experience among pre-service teachers and supervisors. Supervision is seen as collaborative, with university and school staff working closely together. Reciprocity therefore acknowledges the sociocultural aspects of learning to teach (Goos, 2008; Lerman, 2001).

The design of the learning community focused on *teaching* rather than *teachers* (Hiebert, Morris, & Glass, 2003) to develop an educative rather than an evaluative professional experience (Blanton et al., 2001) with on-going engagement of the university supervisor to link methods workshop activities with the pre-service teachers' classroom experiences (Borko & Mayfield, 1995). The learning community also reflected important aspects of the *Standards for Excellence in Teaching Mathematics in Australian Schools* (AAMT, 2006), particularly Standard 2.2 "active exploration of new teaching ideas" and Standard 2.3 "actively engaging and collaborating with colleagues … sharing insights, practices and resources; supporting and mentoring others; and providing feedback" (AAMT, 2006).

The research questions for the study focus on the second and third issues identified by Ponte et al. (2009): What kinds of knowledge about practice did the pre-service teachers develop through their participation in this professional experience learning community? What features of the learning community facilitated the development of this knowledge?

Method

Participants

The study sought to describe the learning community from the participants' perspective so a phenomenological case study design was used. Phenomenological research "seeks the individual's perception and meaning of a phenomenon or experience" (Mertens, 2005, p. 240). Nine pre-service teachers (five female and four male), the entire cohort for secondary mathematics in a one-year Graduate Diploma of Education, participated in the study. The cooperating teacher was the head teacher of mathematics; he had taught for 27 years and supervised 20 pre-service teachers. His previous supervisory practice accorded with the evaluative supervisory roles described by Blanton et al. (2001). He was purposefully selected for the project because of his desire to showcase problem-solving activities in his lessons. The school was a comprehensive government secondary school with an enrolment of about 1 100 boys. The university supervisor (the author of this paper) had been a secondary mathematics education methods lecturer for seven years. He had previously taught secondary mathematics for 20 years and been a cooperating teacher.

The cooperating teacher and the university supervisor designed the learning community program together as a partnership between the school and the university. The pre-service teachers formed two mixed groups (of four and five) matched to a Year 8 class (the highest ability or second-highest ability class) and made six fortnightly school visits each semester, for a total of 12 visits per group over the year. The university supervisor attended all school visits for both groups. The Year 8 lessons were 80 minutes long and there were approximately 30 students in each class. In Semester One, student teachers observed the

cooperating teacher. In Semester Two, they each co-taught two or three lessons with a different partner each time. Bessette (2008) describes co-teaching as "jointly planning, coordinating, implementing, and evaluating … as co-teachers form bonds, teach and learn from one another, and provide mutual support" (p. 53).

Following each class, the cooperating teacher led a 15-minute discussion about the lesson by asking the pre-service teachers to comment on student engagement and learning, why the teacher(s) had acted in a particular way at certain key points in the lesson, and anything else they had noticed. After this, the university supervisor shared his thoughts and posed some questions for the pre-service teachers to consider on their own. Within one or two days, the pre-service teachers wrote a personal reflection about the lesson and posted it to the university online discussion forum. There they could read and comment upon the reflective posts of their peers. Neither the cooperating teacher nor the university supervisor contributed to the online forum. Many of the online posts drew on ideas already discussed in the group after the lesson, but they also included reactions to posts from other pre-service teachers and reactions to the questions raised by the university supervisor during his contribution to the post-lesson group discussion.

Pre-service Program

The methods workshops emphasised constructivist learning theories and challenged pre-service teachers' views about the efficacy of traditional teacher-centred pedagogies by encouraging them to consider reform-oriented approaches such as those recommended in key policy documents (e.g., AAMT, 2006). In alternate weeks, the methods workshops incorporated discussions about the school visits so that the pre-service teachers could further reflect on what they had observed at the school. To provide opportunities for further reflection and analysis of the lessons, the university supervisor identified pertinent comments from the online forum which focussed on features of non-traditional classroom practice evident in the problem-solving lessons. He asked the student teacher to elaborate their ideas and the discussion continued for about 20 minutes as other students shared their reactions and reflections. Even though the student teachers had not all witnessed the same lesson, the problem-solving activity was identical for both classes, so it was possible for everyone to contribute their ideas and be understood by the group. Comparing the variations in the lessons and the student learning outcomes in each case made for some of the most interesting exchanges.

Data Collection and Analysis

A research assistant who was not part of the learning community collected all of the data from pre-service teachers. Pre-service teacher data comprised anonymous questionnaires at the end of each semester and an audio-recording of a 35-minute focus group interview with the nine student teachers held at the end of the year. The author conducted a 20-minute audio-recorded interview with the cooperating teacher at the end of the year. The questionnaires comprised four questions about the pre-service teachers' views on the learning community and how it compared to their other professional experience activities. The group interview stimulated discussion from multiple perspectives to explore the range of participant views (Bogdan & Biklen, 2006).

Data analysis occurred at the end of the year. The author and a research assistant independently analysed the questionnaires and interview recordings. They read the questionnaires multiple times and made detailed notes as they listened to the interview recordings. They used open coding (Strauss & Corbin, 1990) to examine and categorise the

data to identify emerging themes. Later, they compared their initial codes to contrast and refine them. Axial coding (Strauss & Corbin, 1990) helped to establish connections between the refined categories and develop the major themes reported in this paper.

Results

Learning to Link Theory and Practice

The pre-service teachers were unanimously positive in their evaluation of the learning community approach, with many regarding it as the single most important and worthwhile feature of the entire Teacher Education Program.

New teaching practices. The learning community lessons were "unconventional" and "very different from other teachers observed". This contrasted their other school experiences, which they described as "chalk and talk" practices which had little relationship to the constructivist theories they were studying in their methods workshops. They noted that the teaching methods of the learning community classroom "closely reflected theories taught at uni" and began to "realise [that the] teaching theories we learn at uni have real applications". The concurrent classroom and workshop activities of the learning community provided pre-service teachers with a chance to integrate theoretical and practical knowledge and "test a different teaching strategy that otherwise couldn't have been done during normal prac".

The problem-solving lessons of the cooperating teacher demonstrated that constructivist theories could be implemented in realistic classroom settings so pre-service teachers could see that "there is another way to teach maths". They noted how the problem-solving lessons they observed productively engaged students and the evidence of effective student learning encouraged the pre-service teachers to implement some of the learning activities and teaching strategies in their other school placements. "I taught Year 9 one of the [problem-solving] activities. They liked it, they loved it, and the supervising teacher liked it too".

Theorising about teaching. Participation in the learning community also helped pre-service teachers theorise about classroom practices. By observing the cooperating teacher and their peers they understood "there are several ways of teaching mathematics" and "having many approaches brings out great ideas from the students". By reflecting on the successful elements of these lessons they recognised problem solving as a productive mathematical learning experience because "a sense of challenge and purpose to solve a problem increases engagement". And by adopting some of the cooperating teacher's strategies in their co-taught lessons the pre-service teachers became more closely attuned to the notion of teachers as facilitators of learning since teaching is "not only teaching standing at the board and explain[ing]".

Collaborative Learning within the Learning Community

Through observing, co-teaching, discussing and reflecting on each other's lessons, participants had many opportunities to share their experiences and expand their repertoire of pedagogical approaches.

Co-teaching and peer observation. The experience of co-teaching was "empowering" and highlighted how much they could "learn off their peers". In lesson preparation, co-teaching "brings more ideas and approaches to the table" and "encouraged experimentation" because the process of designing the lesson was "less isolated". In delivering the lesson, co-teaching was "less scary with someone for support" and provided a unique opportunity for

pre-service teachers to "learn how to collaborate with another colleague to produce a lesson". Peer observation was valuable because it allowed the student teachers to "see different ways of teaching". Their peers were "at the same level" so it was possible to imagine how they could "put into practice things you liked or thought were effective in others' lessons". Being observed by peers allowed pre-service teachers to receive "quality feedback from different perspectives" and to hear "different aspects of myself from others' point of view".

Group discussions. The group discussions following each lesson were characterised by their richness and variety: "One thing that really comes out clear is that some people have different views on the same thing". The diversity of opinions allowed "alternate perspectives that may not have been previously considered" to emerge and opened up "many different alternative courses of action". Pre-service teachers learnt "many different ways" and "more options" to "enrich the teaching of mathematics" which promoted experimentation at their other school placements. They reported incorporating problem-solving tasks in their lessons, becoming more aware of the need to make lessons relevant to students, and adopting a more constructivist style. Even if some of their initial attempts were unsuccessful, they were encouraged to persevere by repeated exposure to the positive outcomes they discussed in the learning community classroom.

The cooperating teacher. Reciprocity occurred not only among the pre-service teachers but also for the cooperating teacher. He "learnt a great deal" from observing the lessons co-taught by pre-service teachers in the second semester. He explained that he was inspired by their innovative and creative lesson introductions and the ways they used technology to motivate and engage students. The cooperating teacher also commented that "comparing how they teach the same lesson with the way I taught it gives me a lot to think about" and he added that he intended to adapt his teaching of some of the problem-solving activities in the following year. He also found the post-lesson discussions useful because the pre-service teachers "have a perception of things that's really worthwhile [and] it's interesting to hear their ideas about my lessons". He said the group discussions were "very different" to his previous experiences supervising pre-service teachers because "usually discussing a lesson is just a sideline, an occasional thing and then you move straight on to the next class, the next urgent thing that has to be done".

Individual Learning within the Learning Community

The learning community provided opportunities for individual reflection as pre-service teachers wrote a personal critique of the lessons via the online forum.

Becoming more reflective. The pre-service teachers recognised the importance of critical reflection in helping to "increase awareness" about learning and teaching by "making me focus on specifics of the lesson" and "making me think through what I have observed". They found the individual writing task challenging and rewarding because written reflections "provided the opportunity to pause and deeply reflect on the observed lesson". The deliberative act of writing "forces pre-service teachers to pause and think", encouraging them to evaluate learning and teaching outcomes and more acutely consider their strengths and weaknesses. Identifying the positive elements of each other's lessons was affirming, while constructively critiquing the less successful aspects was beneficial as "reflection, particularly writing it down, allows one to identify areas for improvement".

The written reflections allowed student teachers to begin processing the outcomes of the group discussions in a more considered way than they might otherwise have done. Their

reflective practice developed not only through hearing the views of others but also in thinking more deeply about the ideas: "Digesting others' point of view opens up my thinking". These reflections often raised many more questions for the pre-service teachers to consider about the lessons they observed and or taught, such as: "What went wrong? How could things be done better?"

Reflection in action. Reading each other's reflections increased pre-service teachers' awareness of alternative viewpoints and helped them make sense of their classroom experiences as they observed their peers' lessons and critiqued the lessons they co-taught. The group discussions and individual reflections from peers on the co-taught lessons also had an impact on individual pre-service teacher's practice beyond the learning community classroom: "I can take at least one piece of advice and use it in normal prac". Another pre-service teacher summarised her developing reflective practice in terms of a three-stage process "Try, Reflect, Re-model" indicating a connection between her ability to experiment with new pedagogies, think deeply about the lesson observations and discussions, and enact further changes in her classroom practice.

Discussion

Although they found the cooperating teacher's lessons worthwhile, the pre-service teachers reported that co-teaching, observing, discussing, and reflecting on their peers' lessons were the most valuable aspects of the program. In co-teaching, they took greater risks than they could have made done on their own. They were more forthright in their analysis of each other's lessons because it was less threatening to critique the teaching of their peers than an experienced practitioner. They also regarded the successes of their peers as achievable goals which pointed the way towards each person's improved classroom practice. Co-teaching was therefore central in promoting innovative classroom practice as these lessons demonstrated how student-centred teaching approaches could be successfully implemented in a secondary mathematics classroom. Observing and co-teaching these lessons helped to disrupt the 'cycle of tradition' (Frid & Sparrow, 2009) and encouraged the pre-service teachers to develop their professional knowledge of reform-oriented pedagogies.

The combination of learning community activities was carefully constructed as educative rather than evaluative (Blanton et al., 2001) in nature. There was no formal evaluation of the pre-service teachers' co-taught lessons and their reflective writing forum postings were not assessed. Since the problem-solving lessons were distinct from the rest of the Year 8 Mathematics program there was no pressure to cover the syllabus content in preparation for examinations and pre-service teachers had greater freedom in planning and teaching their co-taught lessons. They could experiment more freely with reform-oriented pedagogies than in their other school placements where pressure to complete the syllabus often constrained the implementation of new teaching strategies.

Reflecting on teaching can be difficult for pre-service teachers (Star & Strickland, 2008). As Sim (2006) observed, the key to becoming more reflective lies in exploring and discussing fundamental aspects of practice. The present study confirms this finding and demonstrates two other important features of reflective activities: their quality and synchrony. High quality reflection was achieved through a combination of individual and group tasks, both oral and written, which encouraged pre-service teachers to think more deeply about their experiences. Synchrony of reflection occurred by interweaving the school visits with follow-up activities in methods workshops to mirror the classroom experiences and reinforce the practice of reflection.

Literature on improving the quality of teacher education programs argues for a closer alignment between university studies and field experiences (e.g., Ebby, 2000). Previous research has identified irregular supervisory visits (Blanton et al., 2001) and giving too much attention to classroom management and organisation (Goos, 2008) as problematic. The cooperating teacher and university supervisor were equal partners in the design and development of the learning community; they conceived the program together and developed a supervisory partnership as it progressed. The cooperating teacher shared his experience with problem-solving lessons and the university supervisor provided a reform-oriented theoretical lens through which to interpret and discuss the classroom episodes.

The cooperating teacher and the university supervisor participated in the learning community as co-constructors of knowledge (Lerman, 2001) with the pre-service teachers. The cooperating teacher facilitated the post-lesson discussions so that the student teachers could share their observations and react to each other's ideas and the university supervisor used the ideas proposed by the pre-service teachers to stimulate further discussion and reflection in the workshops. Their aim was to prepare graduates who would engage in the kinds of professional learning envisioned in the *National Professional Standards for Teachers* (Australian Institute for Teaching and School Leadership [AITSL], 2011). In particular, Standard 6.3, which recognises that teachers should "contribute to collegial discussions and apply constructive feedback from colleagues to improve professional knowledge and practice" (AITSL, 2011, p. 18).

Conclusion

All of the learning community participants valued the experience and were able to identify some benefits they gained from taking part in it. Everyone developed a greater appreciation of the importance of mathematical problem solving as a practical way of implementing the reform agenda for secondary mathematics. Intermingling the activities between the classroom and the methods workshop assisted pre-service teachers in establishing strong links between theory and practice. The opportunities for co-teaching and peer observation allowed the participants to collaborate and support each other's learning. Finally, posting individual comments to the online forum helped the pre-service teachers develop a more reflective stance on their personal classroom practice. Above all, the learning community helped to position the pre-service teachers as collaborative partners who recognised the value of learning with and from each other.

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Practical Implications

The results of the study have some important practical implications for the future design of professional experience programs. Although the pre-service teachers benefitted from observing and discussing the problem-solving lessons of the cooperating teacher, they valued most the opportunities they had for co-teaching and peer observation. The lessons of their peers encouraged them to experiment with reform-oriented pedagogies in their normal school placements and it catalysed their reflective thinking.

Co-teaching allowed pre-service teachers to challenge each other in planning and implementing more creative and engaging lessons. In lesson planning, they could critique each other's ideas and keep focusing on improving students' learning outcomes. Co-teaching provided a safe environment for pre-service teachers to adopt reform-oriented teaching strategies and expand their pedagogical horizons. They could take risks together they were not always willing to take on their own and they could practise new skills with a partner who was there to support them. Their experiences of co-teaching enriched their professional practice and gave them the confidence to try out new teaching approaches that they could take into the classroom when they taught on their own.

Observing their peers teach a lesson provided pre-service teachers with a plentiful source of material for discussion about learning and teaching. They were far more willing to deconstruct and critique each other's lessons than those from the cooperating teacher, perhaps because they did not feel comfortable evaluating the practice of a more experienced teacher who was also acting in a supervisory role. Peer observations not only provided valuable feedback for the pre-service teachers who conducted the lesson, they also allowed the observers to hone their ability to notice key aspects of classroom practice.

The other significant outcome of co-teaching and peer observation during the learning community program relates to the ways that these activities encouraged the pre-service teachers to become more reflective practitioners. It can be easy to neglect the processes of lesson evaluation and reflection on learning and teaching during professional experience where the demands of the school environment are keenly felt. However, collaborative teaching and peer observation create a sense of mutual accountability to others so that each person makes a greater effort to share his or her insights during the processes of lesson planning, teaching, and post-lesson analysis. The results of the present study demonstrate that accountability to the professional growth of others was central to the mutual involvement and commitment of pre-service teachers to the progress and success of the learning community.

The author has already begun to create a sense of mutual accountability and commitment by implementing co-teaching and peer observation in the Teacher Education Program for secondary mathematics at his university. Importantly, this is being done without the need for any extra involvement from cooperating teachers or university staff than has typically been the case in the past. As a pilot study, some of the secondary mathematics pre-service teachers are currently completing their entire professional experience in pairs so that they have ongoing opportunities for co-teaching, peer observation, and collaborative reflection on learning and teaching. The combination of classroom and university experiences also continues through a series of School Experience Discussions in which each pair of pre-service teachers report on critical incidents from their practice during the methods workshops. The university supervisor and the other pre-service teachers in the methods workshop support the analysis of these critical incidents.