The Mathematics Enthusiast

Volume 7 | Number 1 Article 6

1-2010

Leading Learning within a PLC: Implementing New Mathematics Content

Ann Heirdsfield

Janeen Lamb

Gayle Spry

Leading Learning within a PLC: Implementing new Mathematics content

Ann Heirdsfield[1]
Queensland University of Technology, Australia

Janeen Lamb[2] *and Gayle Spry*[3]
Australian Catholic University

Abstract: *This paper does two things. Firstly, it examines the literature that coalesces around theoretical models of teacher professional development (PD) within a professional learning community (PLC). Secondly, these models are used to analyse support provided to two year 3 teachers, while implementing the draft Queensland mathematics syllabus. The findings from this study suggest that the development of this small PLC extended the teachers' Zone of Enactment which in turn led to teacher action and reflection. This was demonstrated by the teachers leading their own learning as well as that of their students.*

Keywords: learning communities; mathematical content; teacher professional development; Queensland; theories of teacher development

[1] a.heirdsfield@qut.edu.au
[2] janeen.lamb@acu.edu.au
[3] gayle.spry@acy.edu.au

The Montana Mathematics Enthusiast, **ISSN 1551-3440, Vol. 7, no.1**, pp.93- 112

INTRODUCTION

It is well recognised that teachers face an ongoing challenge in implementing mathematics reforms (e.g., Handal & Herrington, 2003). Given that many elementary teachers are predominantly generalist teachers with little specialist expertise in mathematics education, there is a need to support teachers to develop their mathematics teaching skills.

This paper explores the nexus between theory and practice by using the theoretical model developed by Fullan and Stegelbauer (1991) and Millett and Bibby (2004) as a way to discuss the professional development (PD) supports teachers need when they are being introduced to new mathematics content and pedagogy. To this end, this paper provides an account of a two year project in which teachers conducted a series of teaching experiments aimed at enhancing their content and pedagogical content knowledge in relation to introducing a new content area, mental computation. The following question provided the focus for this two year project:

> What supports do teachers need to enhance opportunities for a professional learning community to develop?

TEACHER CHANGE AND PROFESSIONAL DEVELOPMENT

While educational change has been of concern since the 1960s, the poor history of long term educational change has been well documented (Fullan, 2005; Miles, 2005). However, there have been lessons along the way that have influenced thinking on educational change. Fullan and Stegelbauer (1991) contributed to the discussion on three distinct phases in the change process by promoting a model of change (see Figure 1). They argued that the three phases of "initiation", "implementation" and "continuation" must also include "outcome" indicating the degree to which the school has implemented the change (p. 48). To this end the theoretical model of change they

proposed included "outcome". This position is a reflection of the understanding by the 1990s that professional learning within a community was an important component of successful educational change (Fullan, 2005; Ingvarson, Meiers, & Beavis, 2005; Smylie & Perry, 2005).

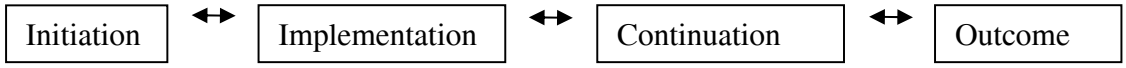

Figure 1. A simplified overview of the change process (Fullan & Stegelbauer, 1991, p. 48)

Linking educational change and professional learning within a community, Millett and Bibby (2004) advance a model of educational change that identifies the "Zone of Enactment" (Millett & Bibby, 2004, p. 3) which extends Vygotsky's (1978) theory on the Zone of Proximal Development (ZPD). While the ZPD focused on the individual, the Zone of Enactment encompassed the professional learning community (PLC). In short, this theory sought to understand a teacher's capacity to change by examining the context and culture of the teacher's 'situation' or working environment. This situation included the professional learning community as well as external influences (see Figure 2). According to Millett and Bibby (2004), sources of support that operated within the "situation" either stimulated a teacher's "zone of enactment" leading to change and hopefully sustainable change, or inaction and ultimately failure of the intended change.

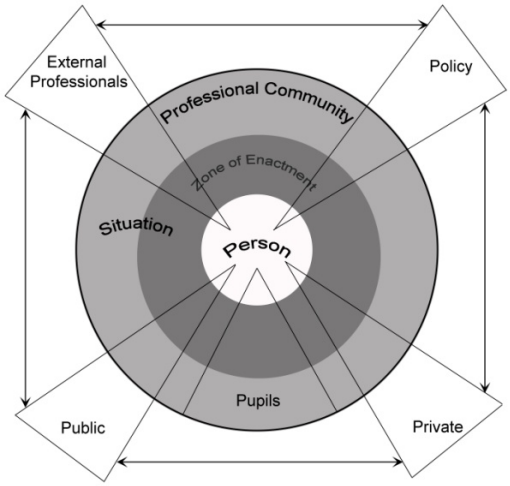

Figure 2. Theoretical model for discussing teacher change (Millet & Bibby, 2004, p. 3)

Millett, Brown, and Askew (2004) identify four conditions necessary for the realisation of Zones of Enactment: time, talk, expertise, and motivation. Firstly, they consider two aspects of *time* essential for the development of a PLC; time for teachers to engage in discussion and reflection, and time for an iterative framework of trial, reflection, discussion, modification, and retrial. Secondly, Millett et al. (2004) report that as teachers were provided opportunities to observe each other's lessons, they were encouraged to *talk* with each other about these observations as a focus for reflection and discussion. This *talk,* in turn, led to the development of *expertise* coming from within the school from teachers leading teachers. Expertise was further developed through contact with external professionals such as university researchers. Finally, *motivation* in several guises was identified as a condition for the realisation of Zones of Enactment. Some teachers were motivated by internal feelings of interest in mathematics, by a desire to improve their mathematics teaching, or from fear of mathematics teaching. Motivation might also have been external; for example, encouragement from colleagues, policy (curriculum changes), and external expert support.

This theoretical model suggests sources of support for educational change and offers a practical way to examine the teachers' Zone of Enactment within the PLC.

THE STUDY

The Context

Two Year 3 teachers, Pam and Sue, participated in a project focusing on developing young children's mental computation. In Queensland (an Australian state), the site of this study, Year 3 students are approximately 8 years of age. At the time of the study, the teachers followed the old mathematics syllabus (Department of Education, 1987), which determined that students in Year 3 should be taught specific written algorithms. In contrast, the new syllabus, which was in draft form (Queensland Studies Authority, 2004), suggested that students should develop mental computation strategies. The students in the two classes (29 students in each class) had been introduced to written algorithms, but had not been taught any mental computation strategies. One aim of the study was to develop teacher content and pedagogical content knowledge through working within a PLC as a way to enhance their agency when implementing the syllabus.

Design

The research reported here adopted a case study design (Merriam, 1998), bounded by two early years teachers from one school. The study was implemented in four phases over two years (see Figure 3). Phases 1 to 3 were repeated in each of the two years. As a way to orientate the reader each phase is described below.

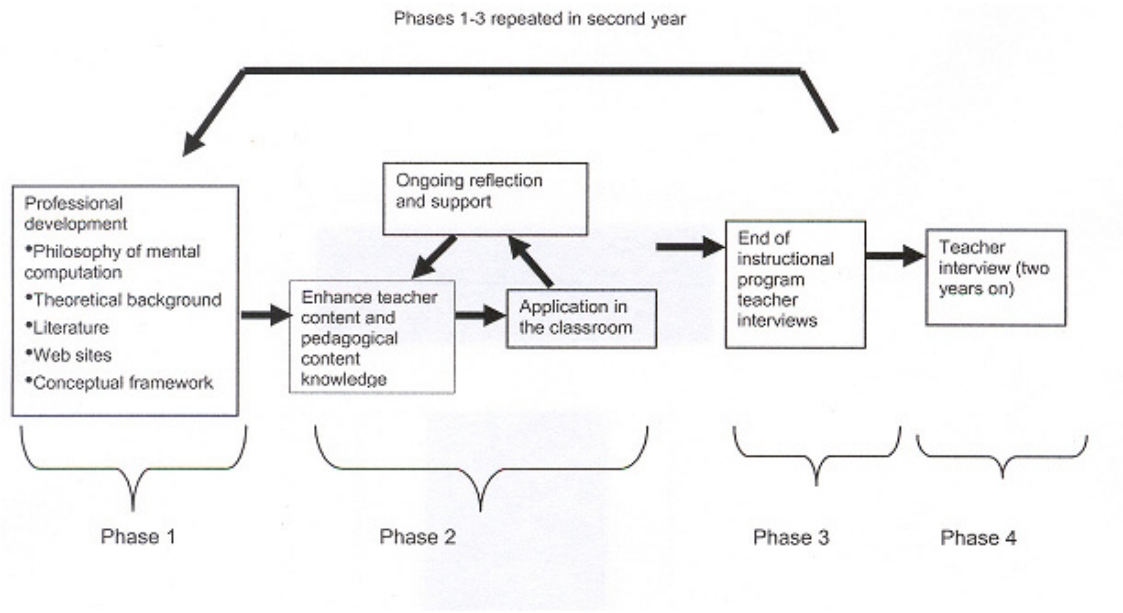

Figure 3. Phases of case study

Phase 1: Initial professional development

In the initial professional development sessions, the first author provided a conceptual framework for mental computation (Heirdsfield, 2003a; 2003b). This framework explained the links between mental computation and related concepts and skills. Additional material included the project summary, relevant web sites, journal articles, the draft syllabus, explanations of mental strategies, and suggested activities to develop mental computation strategies and associated concepts. Pam and Sue studied the philosophy and theoretical background of mental computation before planning the student instructional program.

Phase 2: Implementation phase

The instructional program was designed following the initial PD sessions. While the teachers collaborated, they each implemented different programs in response to both teacher and class

differences. Their instructional programs consisted of eight weekly, one-hour lessons in each year of the two years that the project operated.

Ongoing support and reflection were integral to this implementation phase. During each lesson, the researcher took field notes on the outcomes of the lesson as a way to inform subsequent teaching episodes. During end-of-lesson meetings, feedback was provided on the content and management of the lesson as well as suggestions for further activities. The teachers reflected on student outcomes, and discussed ideas for subsequent lessons with the researcher. Discussions often continued into mid morning recess.

Phase 3: End of project reflection

At the end of each year of the study, the teachers were interviewed. They reflected on their learning, and identified the supports they believed enhanced their professional learning in this community.

Phase 4: Follow up interview two years after the completion of the project

Two years after the completion of the project one of the two teachers was interviewed to discuss the long-term effects of the project and to reflect on the supports she believed enhanced her professional learning. The second teacher had left the school.

Data Collection and Analysis

The data constituted teacher narrative interviews (Auerbach & Silverstein, 2003) conducted at the end of each year of the instructional program and two years afterwards. All interviews were transcribed and coded using a process of qualitative data analysis (Auerbach & Silverstein, 2003). Firstly, relevant text was selected. Secondly, themes were created from this text, using the "conditions" identified by Millet et al. (2004); and finally, the themes were applied to theory.

Results and Discussion

The teacher narrative interviews are examined in terms of the four conditions necessary for realisation of Zones of Enactment – time, talk, expertise, and motivation (Millett et al., 2004).

Time

This current study found that the provision of *time* was an essential source of support for professional learning. The teachers suggested that the PD offered at the commencement of each year of the project and the ongoing access to the researcher provided a very supportive structure through each of the first two phases of the study. However, allocation of time was essential to permit the teachers to engage in this PD.

> Pam: The project provided a very beneficial PD program. But we needed the teacher release time to fit it all in.

This finding has been documented regularly (Durrant & Holden, 2006; Hargreaves & Evans, 1997; Heid et al., 2006), particularly when implementing new content and pedagogy (Lamb, Cooper, & Warren, 2007) or new policy directives (Millett & Bibby, 2004).

Some aspects of time, as mentioned in Millett et al. (2004) were evident in this study – trial, reflection, discussion, and modification. However, retrial was not a factor, as Pam and Sue did not "retrial" lessons in the following year, as they indicated that all classes are different from each other, and what works in one class in one year with one teacher may not necessarily work elsewhere. In fact, Pam and Sue individually trialled new pedagogy in the following year, not as a "retrial", but rather in response to student needs.

> Pam: I love the number board. I get to do a lot with the number board, but I have just taken off with the number line this year. And I think, and I'll tell you

why I do – I bought one. It had never been done before, a lot of number line work has never been done [in this school], and this year I did something with the number line and they [the children] said to me, "but you didn't put the arrows in it. …Last year we did a lot of number line work." I said, "Right I'll do a bit more this year." I didn't have to start at scratch to teach number lines, as the children had been taught before.

Interviewer: But you did, before, didn't you.

Pam: Yes. You had to start at scratch and go through, "this is the number line, which way are you going to have to move?" And that's the result of that of um, doing that number board work I did do that to death because I loved it. …um and I was confident in the number board. The following year, I did a whole lot of activities, prelim activities, on the number board, like cutting pieces out of the number board, yes. That sort of thing – where would I go, what would come next but, give them the idea of placement on the number board. I could have done it on the number line if I was happy about it.

While the teachers were appreciative of the time allocated for PD, and some planning, they believed that they needed additional time.

Sue: We would have liked more time reading. And we needed more time for planning for sequencing [of lessons].

The time allocated to the PD was important, and the ongoing provision of time throughout the project enhanced the commitment of the teachers.

Pam: I only feel sad that we didn't do more with the mental computation as a staff but then I guess staff change a bit, staff move on and I think the sad thing is that something takes place all the time. You know like one year it's mental computation and next year – this year it's grammar. You know, we never actually see something, see it through, practise with it, like we tell the students to do. Practise it and then we think we can do it by ourselves.

Researcher: But you had two years of it so that's better than…

Pam: Yeah, better than a lot of other people… So you can say that I was a bit …spoilt

Talk

This current study also identified two aspects of *talk* that were beneficial to the teachers' professional learning: Teacher-researcher talk and teacher-teacher talk. At the end of each observed lesson, the researcher provided feedback on the conduct of the lesson. When probed about the reflective discussion at the end of each lesson, the teachers were in agreement that this period of reflection supported their ongoing development. The focus of these discussions was mostly on how to target the intent of the lesson and this usually involved encouraging the students to develop their own strategies.

Pam: And I'll tell you what else I found was the feedback we got after each teaching session.

Researcher: Did you feel you had a say in that discussion after the lesson?

Pam: Yeah, and you asked me why I did things.

The teachers also spent time reflecting together. They believed that this collaborative reflection enhanced their own understanding and helped focus their individual lesson development.

Pam: Even when [the researcher] wasn't there we would actually just sit there and say what does this actually mean? Could we go further…are we just going to add on 9 or take 9? Or are we going to go to 19 or 39? All the talking helped us to get the language of mental computation to teach it.

Contrary to the findings reported by Millett et al. (2004), Pam and Sue did not believe that viewing each other's lessons and talking about their observations would have benefited them. They stated their classes were quite different from each other, and, therefore, observations would not have contributed anything to their understanding of their own classes. Instead, collegial reflection on the intent and outcomes of their lessons was more beneficial.

When asked to reflect on the PD and how it was structured Pam commented,

Pam: It really changed my way of thinking…We worked together collaboratively. That made our lessons more successful and we were very honest with each other… All the talking helped us to get the language of mental computation to teach it…The readings and websites were good too but I tell you what was great. The conceptual framework!

Researcher: Do you feel you had ownership of the process?

Pam: Yes I did. Sometimes I wished I didn't because I mucked up a few lessons. But I guess that is what happens when you do own it … and it's new.

Expertise

This current study also identified the contribution of *expertise* to professional learning. Initially, the researcher provided teachers with background information in the form of published research papers and web sites that detailed the philosophy and theoretical background of mental

computation, mental computation strategies, and suggestions for the learning experiences aimed at promoting number sense. In addition, to this background information the researcher provided Pam and Sue with a conceptual framework to guide their practice. During the next two years of the teaching experiment, the teachers utilised the conceptual framework for mental computation (Heirdsfield, 2003a; 2003b) for planning. Pam reported that she not only viewed mathematics with the connections developed in the conceptual framework, she also viewed all learning this way. Further, she still constructed conceptual frameworks before embarking on a new topic.

> Pam: The conceptual frameworks ... have become part of my planning. Your conceptual framework was used to identify where the children were at, and what each child needed. ... I now construct a conceptual framework before I teach anything new. It helps me see the links. …I also think about the links between lessons in my planning.

> Pam: [The conceptual framework] changed my way of thinking. It's not so much thinking; it made me more aware of why we teach certain things. They [concepts] don't come up in isolation.

Consequently, the teachers not only developed more connected knowledge, they also developed a connectionist orientation (Askew, Brown, Rhodes, Johnson, & William, 1997), as evidenced by their developing supporting lessons for topics related to mental computation.

> Pam: In other lessons, when you weren't there, we worked with the children on numeration, you know with MAB [Multibase Arithmetic Blocks – materials used to assist students develop understanding of place value]. And we worked on their number facts strategies. It all had to go together.

Thus researcher's expertise supported the teachers' content knowledge and pedagogical content knowledge. The teachers were empowered by the "materials" provided during the PD. Rhodes and Millett (2004) also reported teachers' enhanced knowledge as a result of having access to a wide range of materials. While this current study clearly identified the importance of the expertise provided by the researcher, the data also highlight the importance of the contribution of teacher expertise. In short, the researcher's expertise in relation to mental computation complemented the teachers' classroom expertise. Pam and Sue spent time together reflecting on and discussing their lessons even though they developed their lessons individually. Pam discussed her preparation of lesson plans as supporting her construction of knowledge, again being responsive to her Zone of Enactment.

> Pam: It forced me to become aware of the sequencing required to develop mental computation strategies.

Further, follow up conversations with her colleague helped Sue to refine her lesson plans. This finding is in line with Rhodes and Millett (2004) who questioned whether teachers who were not actively involved in the planning of lessons always developed a depth of understanding they would have had, had they been partners in the process. The teachers, themselves, also developed expertise, as a result of discussing and reflecting collaboratively.

> Pam: Now you take things on board that you feel confident with. And I felt confident with that so I did take that on board well.

Thus these teachers recognised both their own and each other's expertise as well as that of the researcher. While the researcher remained the "expert" in relation to mental computation, the teachers were considered "experts" in their classrooms. The researcher's expertise supported the

teachers' content knowledge and pedagogical content knowledge. The teacher-researcher relationship was deemed to be of mutual benefit.

Motivation

Finally, this current study identified the part played by *motivation* to professional learning. As indicated by Millett and Bibby's (2004) theory, the majority of the teachers were primarily stimulated to learn by external motivators such as a new policy, curriculum document or accountability requirements. Here it was claimed that without the need to meet new external requirements, most teachers would lack motivation. This certainly proved to be true for the majority of the teachers in this present study. However, the reaction of Pam and Sue to the project suggests that we should not discount internal motivation.

While external motivation in the form of curriculum change might have played a small part within this current study, internal motivation seemed to be the driving force for Pam and Sue.

> Pam: And at the time I was looking for something a little bit different in professional development too. I mean I'm only going to be teaching a couple more years, before retirement… You need to take the challenge. When the challenge goes out I'll retire.

These teachers had begun to lead their own learning. However, this did not automatically extend to the whole school community. In contrast, the other teachers in the school were not interested in pursuing PD in relation to mental computation, although mental computation was mentioned in the draft syllabus at that time.

> Researcher: During the project, was there talk throughout the school about mental computation or was no one else interested?

Pam: No, no one was interested. The syllabus was only in draft form then.

Beyond this initial internal motivation, the fact that the Pam and Sue chose to plan individually may have sustained their motivation through the study. By having to develop their own lessons, the teachers in the present study appear to have acquired a sense of ownership of the lessons supporting the work of Joyce and Showers (1995).

Conclusion

This project highlighted the importance of time, talk, expertise, and motivation, the "four key conditions necessary for the realisation of rich zones of enactment" (Millet et al., 2004, p. 250). Within this project, time and talk enabled trial, reflection, discussion, and modification (of subsequent lessons). External expertise was deemed to be essential to support teachers' learning with respect to new content knowledge and pedagogical content knowledge. It seemed that time, talk, and expertise complemented internal motivation, resulting in "deep change" (Millet et al., 2004, pp. 246-250). In the follow up interview during phase four of this study, it is worthy of note that the supports (i.e., time, talk, expertise, and motivation) offered during the conduct of the teaching experiment had not been continued. In addition, the school now has only one of these teachers to draw on as the expert. No time has been allocated for her to support her colleagues in the PLC that incorporates the whole school. However, in order for collaborative knowledge construction to extend to the full school, external motivation, prompted by policy change, is not sufficient on its own, and time becomes the critical issue. In addition, these two teachers needed two years of ongoing assistance from the external expert to provide the necessary expertise for them to develop a sense of agency and to lead their own learning and that of their students in this new content area. In contrast, opportunities for talk to assist in leading

the learning of colleagues appear to be restricted to staffroom discussions. As a way forward, it seems that focusing on the PLC (Millett & Bibby, 2004) while at the same time recognising that change is implemented through phases is critical for understanding educational change. For this study, the PLC needed the ongoing supports of time, talk, expertise and motivation to carry them through the phases of change. Of particular importance here has been the teachers' participation in acquiring new/background knowledge so that they understood 'what' should change as well as 'why' it should change. These questions led them to vision 'how' they should go about this change. With the support of ongoing expertise, the teachers collaboratively as well as individually planned and then implemented a phase of action and reflection. It seems that critical to the success of progression through the phases and them gaining in momentum has been the provision of time, talk, expertise and motivation. This theoretical perspective combines the features of Fullan and Stegelbauer's (1991) and Millett and Bibby's (2004) models resulting in a new model as seen in Figure 4.

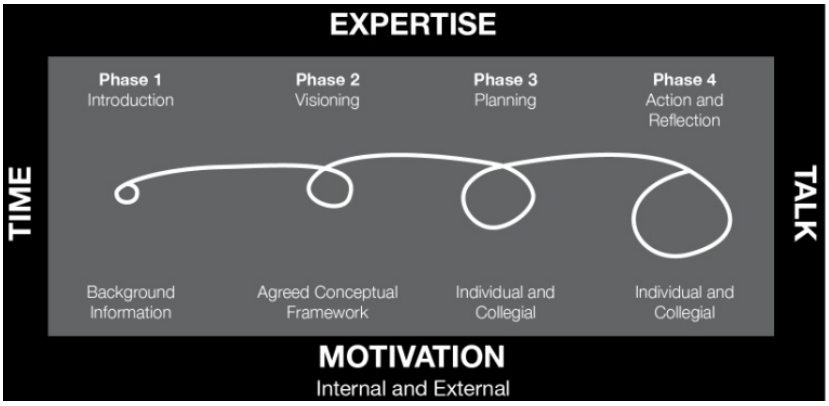

Figure 4. Model for discussing ongoing educational change within a PLC

Further research on the theoretical model developed here is necessary. It is important to work towards an understanding of establishing a professional learning community where; time, talk, expertise and motivation are provided or inherent. Under these circumstances careful tracking of

the teachers within the PLC through the phases of introduction, visioning, planning and action reflection would lead to a greater understanding of sustainable educational change within a PLC as it goes through phases of implementation.

References

Askew, M., Brown, M., Rhodes, V., Johnson, D., & William, D. (1997). *Effective teachers of numeracy* (Final Report). London: Kings College.

Auerbach, C. F., & Silverstein, L. B. (2003). *Qualitative data: An introduction to coding and analysis*. Retrieved September 28, 2008, from http://site.ebrary.com.ezp01.library.qut.edu.au/lib/qut/docDetail.action?docID=10078435

Department of Education, Q. (1987). *Years 1 to 10 mathematics syllabus*. Brisbane: Government Printer.

Durrant, J., & Holden, G. (2006). Teachers as leaders of learning. In J. Durrant & G. Holden (Eds.), *Teachers leading change: Doing research for school improvement*. Thousand Oaks, CA: Sage.

Fullan, M. (2005). *Leadership and sustainability: System thinkers in action*. Thousand Oaks, CA: Corwin Press.

Fullan, M., & Stegelbauer, S. (1991). *The new meaning of educational change*. New York: Teachers College Press.

Handal, B., & Herrington, A. (2003). Mathematics teachers' beliefs and curriculum reform. *Mathematics Education Research Journal, 15*(1), 59-69.

Hargreaves, A., & Evans, R. (1997). Teachers and educational reform. In A. Hargreaves & R. Evans (Eds.), *Beyond educational reform: Bringing teachers back in* (pp. 1-18). Buckingham: Open University Press.

Heid, M., Middleton, J., Larson, M., Gutstein, E., Fey, J., King, K., et al. (2006). The challenge of linking research and practice. *Journal for Research in Mathematics Education, 37*(2), 76-86.

Heirdsfield, A. M. (2003a). "Spontaneous" mental computation strategies. In N. A. Pateman, B. Dougherty, & J. Zilloux (Eds.), *Proceedings of International Group for the Psychology of Mathematics Education* (pp. 55-62). Honolulu, USA: University of Hawaii.

Heirdsfield, A. M. (2003b). Mental computation: Refining the cognitive frameworks. In L. Bragg, C. Campbell, H. Herbert, & J. Mousely (Eds.), *Mathematics Education Research: Innovation, Networking, Opportunity* (pp. 421-428). Geelong, Australia: Deakin University.

Ingvarson, L., Meiers, M., & Beavis, A. (2005). Factors affecting the impact of professional development programs on teachers' knowledge, practice and student outcomes and efficacy. *Education Policy Analysis Archives, 13*(10), 1-27.

Joyce, B., & Showers, B. (1995). *Student achievement through staff development: fundamentals of school renewal* (2nd ed.). White Plains, New York: Longman.

Lamb, J., Cooper, T., & Warren, E. (2007). Combining teaching experiments and professional learning: Conflicts between research and teacher outcomes. *Mathematics Education Research Journal, 19*(3), 73-92.

Millett, A., & Bibby, T. (2004). The context for change. In A. Millett, M. Brown & M. Askew (Eds.), *Primary mathematics and the developing professional* (pp. 1-17). The Netherlands: Kluwer Academic Publishers.

Merriam, S. (1998). *Qualitative research and case study applications in education: Revised and expanded from case study research in education.* San Francisco: Jossey-Bass Publishers.

Miles, M. (2005). Finding keys to school change: A 40 year odyssey. In A. Lieberman (Ed.), *The international handbook of educational change: The roots of educational change* (pp. 1-8). Dordrecht, The Netherlands: Springer.

Queensland Studies Authority. (2004). Year 1-10 Mathematics Syllabus. Retrieved June 13, 2006, from www.qsa.qld.edu.au/qsa/pd/workshops/1to10/math_opt_1.html

Rhodes, V., & Millett, A. (2004). The mediating role of textual materials in teachers' response to calls for classroom reform. In A. Millett, M. Brown, & M. Askew (Eds.), *Primary mathematics and the developing professional* (pp. 97-125). The Netherlands: Kluwer Academic Publishers.

Smylie, M., & Perry, G. (2005). Restructuring schools for improving teaching. In M. Fullan (Ed.), *Fundamental change* (pp. 306-335). The Netherlands: Springer.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.