Teacher Change in Response to a Professional Learning Project

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This paper reports on change in teachers' perceptions of important elements of their role as teachers of mathematics at the conclusion of a two-year professional learning project. Analyses of written responses to survey items indicated shifts in four categories describing important elements of their role: teaching skills, knowledge, concepts; developing problem solvers; facilitating learning by providing quality activities, tasks, and resources; and fostering positive attitudes towards mathematics learning. Teachers attributed these perceived changes to the integration of a number of components within the project.

Teaching is a complex craft involving many skills. It can also involve the artistry and enjoyment of combining these skills into cohesive and effective lessons that are productive learning experiences for students. But as indicated by Hargreaves (1994), teachers each play a key role in the learning experiences of the students they teach:

> Teachers don't merely deliver the curriculum. They develop, define it and reinterpret it too. It is what teachers think, what teachers believe, and what teachers do at the level of the classroom that ultimately shapes the kind of learning that young people get. (Hargreaves 1994, p. ix)

We propose that few involved in teacher professional development would be in disagreement with Hargreaves as to the importance of teacher beliefs, along with other factors, for their potential impact on the learning experiences of students. Research indicates that beliefs are commonly seen to be stable (McLeod, 1992) but "can be held with varying degrees of conviction" (Thompson, 1992, p. 129), with the consequence that the more central beliefs are resistant to change (Rokeach, 1968). On the other hand, this implies some beliefs may be open to change by outside influences.

It is generally accepted that there is a relationship between teacher beliefs and teacher practice (Koehler & Grouws, 1992; Philipp, 2007), although researchers report varying degrees of consistency between teachers' professed beliefs and their actual instructional practices (Philipp, 2007). It is noted also that, although current documents encourage a view of mathematical activity as an active process (e.g., Australian Association of Mathematics Teachers, 2006), the majority of teachers appear to maintain traditional forms of mathematics teaching (Franke, Kazemi, & Battey, 2007) that do not necessarily facilitate such mathematical activity. In considering inconsistency in teacher beliefs and practice, Clarkson and Bishop (2000) found a difference between studies that relied solely on self report data by teachers and studies that included some element of observational and/or in-depth discussion over a number of meetings with teachers. Hence they used values to refer to beliefs that a teacher is seen to enact within a classroom, as compared to beliefs that the teacher may or may not embed within their act of teaching. Nevertheless beliefs and values need to be addressed when developing professional learning programs for teachers. It would seem that if teachers are to change their practice in classrooms, then one key necessary element may be a change in articulated beliefs, although this may not be sufficient for practice to actually change. Models of teacher change help in considering this question.

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Guskey (1986) claimed that teachers change their beliefs through changing their practice and reflecting on the result. Clarke and Hollingsworth (2002) further developed Guskey's model, viewing the process as cyclical with multiple entry points (see Figure 1). Their model, of what they termed teacher professional growth, took account of four distinct domains that encompass the teacher's world. The model assumes that change occurs through the mediating processes of reflection and enactment.

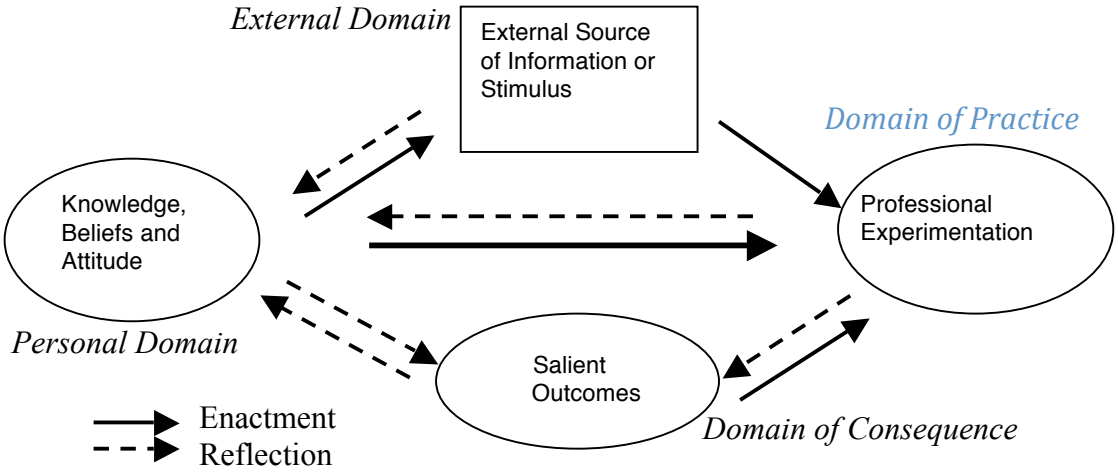

Figure 1. Clarke-Hollingsworth (2002) model of teacher professional growth.

One of the outcomes from the Clarke-Hollingsworth (2002) model is that the validation of the veracity of different beliefs for teachers' needs to be through observation of positive student learning.

Noting this research, it is argued that it is best to devise professional learning programs that are centred on children's thinking and practice in classrooms, and this will impact on teachers' beliefs about the teaching of mathematics as a step in changing their teaching practice. There is some evidence to support this approach (McDonough & Clarke, 2005). Based on these notions, the present study was designed to investigate whether change in teachers' beliefs would occur within a group of teachers who participated in a professional learning project that lasted for two years. The research questions addressed here are:

- What was the nature of the practices the teachers reported at the beginning of the professional development project as compared to the end of their second year of participation?
- If there were changes in what the teachers reported, what did they believe influenced these changes?

The Research Setting and Methodology

The teachers whose responses are reported in this paper taught at eleven Catholic primary schools in and around Melbourne, Victoria. They were involved in a professional learning project titled Contemporary Teaching and Learning of Mathematics (CTLM) (Clarke et al., 2009). The main aim of CTLM was the enhancement of pedagogical content knowledge of teachers, which would lead hopefully to an improvement in student mathematics learning. This project was led by teacher educators from Australian Catholic University (ACU) and sponsored by the Catholic Education Office Melbourne (CEOM).

The content focus of the project in 2008 was on Number, Structure, and Working Mathematically, and in 2009 on Space, Measurement and Chance and Data, with an additional focus on the characteristics of effective teachers of mathematics. Pedagogical aspects for the primary classroom that were given some focus included questioning, assessment, and creating a community of learners. The teachers participated in twelve full days of professional learning over the two years. Between these days, teachers undertook a range of teaching and assessment activities related to the project. They were supported in classrooms, in school professional learning team meetings, and at the professional development days by a variety of people including fellow teachers, CEOM staff and ACU teacher educators and pre-service teachers. During 2008 parent information evenings promoting key aspects of CTLM were held in all schools. It might be said that, in line with principles of good professional development (Clarke, 1994), teachers were supported in a range of ways through the sharing of a vision for teaching mathematics, and the practical support of colleagues, administrators, parents, and others outside the school community.

One aspect of the research component of CTLM was a survey on teacher background and confidence with different aspects of the teaching of mathematics. The data reported in this paper were gathered from a total of 148 teachers in April 2008 and from 98 in October 2009, and reports their responses to two specific items regarding their views on teaching, and one item that asked them what aspects of the project they found most helpful.

While recognising possible limitations of self reported data, and the problematic relationship it has with potential teaching behaviour, we nevertheless judged it appropriate to ask teachers to describe practices that occur in their classrooms, and to communicate what they saw as important elements of their role as primary school teachers of mathematics. We believe that teachers' expressed beliefs are closely related to their actions, although we acknowledge such beliefs may not be sufficient for action.

The first of the two items discussed was an open response item that sought teachers' responses as to what they believed were the important elements in being a mathematics teacher. We were interested to see whether or not their beliefs changed over the two-year period and, if so, whether the changes were in line with the messages emphasised by the CTLM project. The second item was more specific but captured a crucial element of what the CTLM project was built around: communication and the type of activities students were asked to engage with in the classroom. It was anticipated, at the time of commencement of CTLM, that communication in classrooms would likely involve the students listening to teacher talk, with students frequently requested to complete exercises based on material already explained to them. Much of the CTLM project asked teachers to encourage their students to explore possible strategies for solving problems, and then provide explanations for what they had done.

By reporting teacher responses to the two items, we attempt to capture their generalised responses to the project, juxtaposed with specific responses related to a core component of the project. We would hope to see some synergy between the two clusters of responses.

Results and Discussion

In this section we begin by addressing the first research question by reporting findings on two related survey items gathered from all teachers (Years Prep to 6) about their perceptions of aspects of their teaching of mathematics at the beginning and conclusion of the two year CTLM professional learning project. We then consider responses to one questionnaire item that give us insights into the second research question regarding factors of influence.

Four broad categories captured most teacher responses to the open ended item: What do you see as the most important elements of your role as a mathematics teacher of primary-aged students? These categories were

- teaching mathematics (skills, knowledge, concepts etc.);
- developing problem solvers;
- facilitating learning through providing quality activities, tasks, resources; and
- fostering positive attitudes towards mathematics learning.

Due to limitations of time and space on the survey, teachers were asked to respond with one, or at the most two, ideas for this item, with most teachers responding with one idea. Hence one can argue that their responses are probably the most important to them. All teachers at both the beginning and end of the CTLM project completed this item. We have graphed the average number of responses per teacher for each category (see Figure 2).

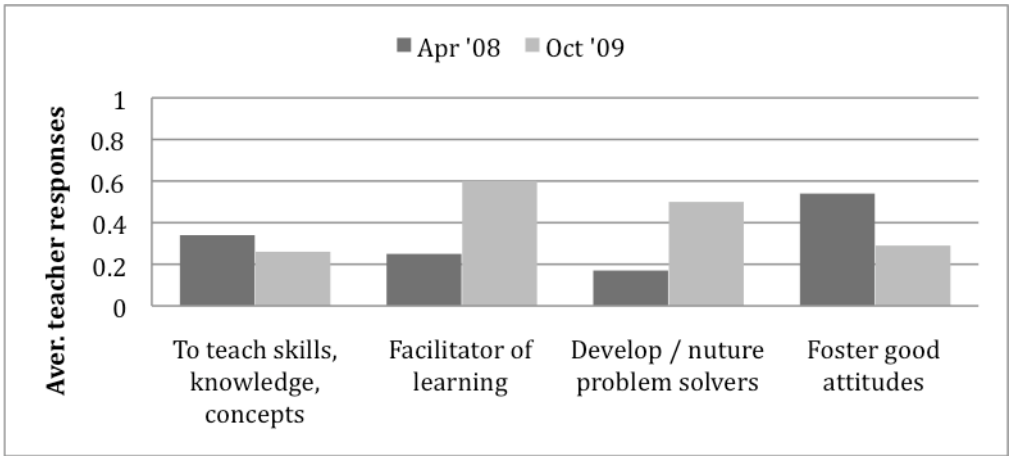

Figure 2. Teachers' perceptions of their roles as teachers of mathematics

These data suggest that the teachers' perceptions about their role changed in important ways over the duration of the project. We comment on three key findings. At the beginning of the project, many teachers indicated that an important element of their role was to teach knowledge, skills and concepts. In their descriptive responses many teachers described ways in which they impart knowledge, skills and concepts so these could be used in the future at secondary school, or in real-life contexts. For example, one wrote: "To teach them the basics and how these are used in different ways so they can relate it to other things." However, by the end of the project, more teachers indicated that they saw themselves as facilitators of learning by providing students with suitable tasks and by asking questions so that students could think more deeply about their ideas. A common sentiment was captured in this teacher's response: "Being a facilitator of their learning [involves] giving them questions and experiences that lead them to come to their own conclusions." Another wrote: "I am the facilitator - the one who encourages and supports the students. I ask questions to promote thinking but I also help students to ask their own questions."

The second finding that is worth noting here is the rise in the number of responses for developing or nurturing problem solvers. For example, one wrote: "To enable the students to see that there is more than one way to get an answer and to realise the correct answer is not the be all and end all." Another common response involved getting students to articulate their thoughts with others. For example, one teacher wrote: "Allow students to

investigate, experiment, share ideas and strategies." Another commented: "For children to explore alternatives, to feel confident enough to attempt investigations and to identify why they came to their conclusions/answers."

The third finding concerns students' attitudes. At the beginning of the project, many teachers considered a key aspect of teaching mathematics was to foster a positive attitude towards mathematics. They expressed this sentiment in very general terms. For example, one teacher stated: "To give children a positive attitude towards maths and to make it fun." Of course, it is important to be supportive and to foster positive attitudes in mathematics, although we acknowledge that more is needed to produce sound mathematical understanding and critical thinking skills in students. We note in the teachers' initial responses some emphasis on making mathematics non-threatening. Yet, current thinking in mathematics education (e.g., Australian Association of Mathematics Teachers, 2006) advocates that it is important to also challenge students by providing tasks and experiences which they can ponder, explore, and even struggle with for a short time, so that they will learn to persevere, try different strategies and extend their mathematical understandings. Inevitably some students will find such situations threatening to some degree, particularly if they perceive that there is no safety net provided.

By the end of the project we noted a change, for example, a typical response was: "To get children excited and interested in maths". This seemed to be a productive way to foster positive attitudes towards mathematics with students. In fact, in many cases, teachers started to make more specific comments on ways to value and support students' thinking during mathematics lessons which may lead to fostering positive attitudes to learning mathematics. For example, one teacher wrote: "Providing the context, materials, support and encouragement for students to recognise their own style of learning; to provide knowledge and skills, thinking processes and real world experiences to develop and practice problem solving strategies". Another stated: "To provide experiences that enable students to visualise their maths. To link maths with real life scenarios. To build competency with mental computation/place value. To encourage discussion about maths at home and among peers". It seems likely that in classrooms where all students' opinions and strategies are considered, there would be more opportunities to cultivate positive attitudes in mathematics lessons.

The second item from the questionnaire that is of interest is shown in Figure 3. The student behaviours described in (a) and (b) were to some degree de-emphasised during the CTLM project, but behaviours described in (c) through (g) received emphasis at various points in the project.

How often do the students in your mathematics class do the following?
This stem introduced the following:
a) Listen to me present the definition of a term or the steps of a procedure.
b) Perform tasks requiring methods or ideas already introduced to them.
c) Assess a problem and choose a method to use from those already introduced to them.
d) Perform tasks requiring methods or ideas not already introduced to them.
e) Explain an answer or a solution method for a particular problem.
f) Analyze similarities and differences among representations, solutions, or methods.
g) Prove that a solution is valid or that a method works for all similar cases.
For each item, teachers were asked to choose from six alternative columns that were headed: (1) never, (2) less than once a month, (3) 1-3 lessons per month, (4) 1-2 lessons per week, (5) 3-4 lessons per week, or (6) 5 lessons per week.

Figure 3. Item asking teachers for their perceptions of types of student classroom participation

The average teacher responses are shown in Figure 4. If the CTLM project was influencing teachers' teaching, then there would be an expectation that the responses for (a) and (b) would fall, but a rise would be seen for (c) through (g). Indeed this is the result that occurred for these teachers who had been in the CTLM project over a two-year period. The changes for (b) through (e) were 0.4 or less. Such a change on a six-point scale is probably not indicative of real change, although it is gratifying that the movements are in the expected directions. For items (a), (f) and (g) there is a change of 0.5, 0.6 and 0.7 respectively. On a six-point scale such changes are probably indicative of some educationally important movement for these teachers. Noting a fall away from the very traditional approach (a), and a rise in emphasis on analysis (f) and proof (g) suggests that the project has altered what these teachers are attempting to do in their classrooms.

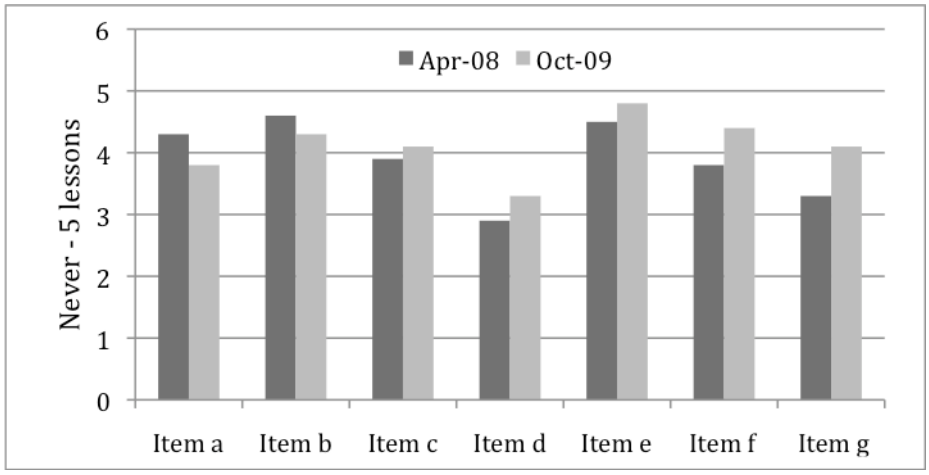

Figure 4. Teachers' perceptions of types of student classroom participation

We suggest there are some interesting points to note by taking the responses to these two items together. The drop in teachers' stated belief that teaching mathematics was about facts and skills is consistent with the change noted for items (a) and (b) where teachers suggest they are telling less in class. We also note that teachers' rising belief that it is worthwhile to be a facilitator and nurture problem solving is consistent with an emphasis on students analysing similarities and differences between solutions and methods, and proving a solution or method is valid in other cases. Overall, these data indicate some shift away from teacher-directed instruction, suggesting the teachers believe more in a non-traditional than a traditional mode of teaching mathematics. The teachers' written responses emphasised exploration and experimentation of concepts through open-ended tasks, and the use of high-order thinking processes such as explanation, evaluation and justification in their second set of responses, and are consistent with their responses in Figure 4, as well with the goals and foci of the CTLM project.

Given that we believe that we detect a change in this group of teachers, we address our second research question: If there were changes in what the teachers reported, what did they believe influenced these changes? At the conclusion of the project teachers responded to an open ended item on the survey: What aspect/s of the CTLM project have been most helpful for you this year (2009), and in what way/s have they been helpful?

Many teachers referred to multiple aspects of the CTLM project in identifying the most helpful aspects of the project and in some cases they used words like 'everything' or 'all of it' and 'useful activities' which made it difficult to distinguish between specific

components; hence, we decided not to represent the data in a graph. However, all but two of the ninety-eight responses were positive about their involvement in the project.

It seemed that the combination of aspects was helpful in achieving a balance between unpacking theoretical principles and considering advice for classroom implementation. Teachers valued the input addressing key issues during the professional development sessions and the flow on support offered to them back at school, for example one wrote: "Change in thinking and the way mathematics is taught in the classroom; PD that has been practical; Being able to trial activities; Planning sessions with [project support staff back at school]". Comments referring to staff supporting the project back in schools frequently made reference to teachers who were mathematics leaders at their school, Catholic Education Office (Melbourne) staff, and Australian Catholic University staff. Teachers seemed to appreciate that the activities presented to them were 'ready for classroom use' as comments such as "the students enjoyed doing them" imply that teachers had used them. An entry which captured the sentiment of the majority was "The ability to have time to read, discuss, do hands on activities has refreshed me as a teacher of maths!" This suggests that teachers valued the project because it provided both time to observe and listen to new ideas, as well as space and support to experiment, gain confidence, and reflect upon new insights and practices. Most teachers thought that they had improved in their teaching as a result of their involvement in the CTLM project.

Conclusion

In the current study teachers were exposed to external sources of information (Figure 1), that is, stimulus through participation in a professional learning project over a two-year period. This involved working with educators from outside their school, but also collaborative research activity within their own school community. In line with Philipp's (2007) argument that it is more important to support teachers to change beliefs and practice in tandem than to worry about determining which changes first, the CTLM project gave teachers support in their teaching. The data analysed here suggest most teachers who participated in the CTLM project probably changed their beliefs and teaching in ways consistent with the aims of CTLM. Not only is this valuable feedback to the designers of this project as they continue with further groups of teachers, but potentially for other providers of professional learning. Nevertheless we acknowledge the limitations of this study and, echoing earlier points, suggest there is value in more fine-grained analysis of teacher articulated beliefs and their relationship to what actually happens in classrooms, both for the purpose of verification of teacher statements of their practice and views, and to give deeper insights into how teacher change can be stimulated (Clarkson & Bishop, 2000; Speer, 2008).

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