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Professional Learning Opportunities in the Classroom: Implications for Scaling Up System-Level Professional Development in Mathematics

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The New Zealand Numeracy Development Project is an example of a professional learning and development initiative that has been progressively scaled up across a system to improve teacher knowledge and practice and student outcomes in mathematics. This paper examines two elements of the project's design that have been pivotal in enabling teachers to adopt ambitious pedagogical practices in mathematics: classroom-focused opportunities to learn and access to external expertise. Four aspects of facilitator practice that impact on teachers' practice are identified: a focus on students' mathematical thinking; the use of pedagogical tools to structure teaching tasks; modelling and the provision of commentary; and observation and the provision of feedback. The question of sufficiency of professional learning and development opportunities is raised, particularly in enabling all teachers to respond to the challenge of providing equitable opportunities to learn for a diverse student population. The challenge of how systems can build the capability of facilitators so that they can engage teachers in substantive new learning and practice is highlighted as an important area for further investigation.

Introduction

In drawing attention to the nature of system change, Coburn (2003) has suggested that "to be 'at scale', reforms must effect deep and consequential change in classroom practice" (p. 4). Such change needs to go "beyond surface structures or procedures (such as changes in materials, classroom organization, or the addition of specific activities) to alter teachers' beliefs, norms of social interaction, and pedagogical principles as enacted in the curriculum" (p. 4). Therefore, a major challenge for education policy makers and reformers relates to how to change the *difficult-to-reach dimensions* of classroom practice, such as classroom discourse, in order to achieve the demanding goals of complex instruction and better learning outcomes for all students (Spillane & Jennings, 1997). The focus of this paper is on classroom-situated professional learning opportunities for teachers, with a specific focus on the role of the facilitator working alongside teachers to develop their classroom practice.

Internationally, in-service professional learning and development has been identified as a key area of investment and a lever for improvement in the quality of teaching and student outcomes. The McKinsey Report (Barber & Mourshed, 2009) identified the development of human capital through "continuous improvement of pedagogical skills and knowledge" (p. 13) as an important building block for world-class education systems with "no more important

empirical determinant of student outcomes than good teaching" (p. 27). For instance, over three years, learning with a high-performing teacher rather than a low-performing teacher can make a 53-percentile difference for two students who start at the same achievement level (Sanders & Rivers, 1996).

In his discussion of professional development as a path for policy dissemination, Knapp (2003) highlighted the need to pay attention not only to the design and implementation of professional learning opportunities, but also to the infrastructure at various levels of the system. This included the development of sufficient expertise in "supporting professional learning through policy in such a way that teaching practice and student learning are affected" (p. 147). In a recent review of the lessons learned from education reform in the last fifty years, Levin (2010) has identified the lack of attention to the adequacy of implementation as a major flaw in the policy process. He highlights two elements that are critical to successful implementation: the importance of engaging those who must make the change in the process of learning and improvement, and the need for "enough skilled people to provide ongoing support" (p. 742). As Bryk (2009) pointed out: "Knowing that a program [or policy] can work is not good enough; we need to know *how to make it work* reliably over many diverse contexts and situations" (p. 598).

In considering two interrelated elements of professional development design – classroom-focused opportunities to learn, and access to external expertise – this paper specifically examines the function of external expertise in changing the *difficult-to-reach dimensions* of teacher practice from a facilitator's perspective and argues that situating professional learning opportunities in teachers' classrooms enables facilitators to engage teachers in the project's core ideas and enact these in practice. Such a focus is important to policy makers and reformers because it expands our understanding of what is required to enable change at the sites of implementation, in this case, the school, in addressing the challenge of achieving improvement across an education system.

The initiative that is the focus of this paper is the New Zealand Numeracy Development Project – a large-scale, multi-level, government-funded strategy for improving the teaching and learning of mathematics in New Zealand schools through improving the professional knowledge, skills and confidence of teachers – that was implemented from 2000 to 2009. The design of the Numeracy Development Project drew on theoretical understandings associated with a situative perspective on teacher learning and professional development (Putnam & Borko, 1997, 2000). Using a socio-cultural perspective, Putnam and Borko (1997) conceptualised teacher cognition as: "(a) situated in particular physical and social contexts; (b) social in nature; and (c) distributed across the individual, other persons, and tools" (p. 4). This perspective of teacher cognition as situated, social, and distributed, positions the classroom and the school as primary contexts for teacher learning. In the case of the Numeracy Development Project, the three key elements that reflected a situative perspective in the design of the professional learning and development approach included:

a) the use of three pedagogical tools that promote new knowledge and practice;

b) the contextualisation of professional learning within the teacher's site of practice; and
c) the function of external expertise in facilitating teacher learning.

For policy makers and reformers, the design of the Numeracy Development Project was significant because of its scale – 97% of New Zealand primary schools have participated in the project – and because it was the first system-wide New Zealand initiative in which the professional learning and development focus was located in the individual teacher's classroom where facilitators engaged with the fine-grained detail of teaching practice. The research and development approach adopted (Higgins & Parsons, 2011) enabled policy makers, researchers and practitioners to learn about what is successful, as well as the challenges involved, in improving professional practice.

Research and evaluation findings from the project provided evidence of improved student outcomes (Thomas & Tagg, 2009; Young-Loveridge, 2009) and increased teacher knowledge, skills and confidence in mathematics (Thomas, Tagg, & Ward, 2003). However, despite this evidence of success, challenges remain for the next phase of development in mathematics education in New Zealand. In the discussion section of the paper we highlight those challenges and consider implications for the design and implementation of system-wide professional development initiatives that improve classroom practice and student outcomes.

Features of Professional Learning and Development Design

In recent years, a strengthening evidence base has enabled us to identify important features of the design of professional learning and development opportunities for teachers that improve instructional practice and outcomes for diverse learners (Bishop, Berryman, Cavanagh, & Teddy, 2009; Borko, 2004; Borko, Jacobs, & Koellner, 2010; Desimone, 2009; Timperley & Alton-Lee, 2008). Core features of effective professional development recently identified by Borko et al. (2011) and Desimone (2009) have similarities, although there are obvious differences in terminology and organisation. Borko et al. divide their characteristics into those relating to content and those relating to process/structure, identifying eight characteristics in total, while Desimone identifies five core features. Both sets of features include content-focused professional development, active teacher learning, collaborative learning, aligning the professional development setting with the professional development goals, and ongoing opportunities for professional development. The core features provide a useful frame for comparing school-based professional development initiatives in terms of sustainability and scalable models.

The significance of the consensus around the important features of a content focus, active learning, coherence, duration, and collective participation is strengthened by studies highlighting the importance of instructional leadership in creating the conditions for teacher learning. Robinson (2007) has argued that the leadership dimension that has greatest impact on student outcomes is the

promotion of, and participation with teachers in, professional learning. More recently, Higgins and Bonne (2011) considered how different configurations of leadership enactments might create the conditions that foster ownership of reform practices by those in various roles in a school.

Professional learning is strongly shaped by a teacher's context of practice, which includes the classroom and the wider school culture, as well as the community and society in which the school is situated (Timperley, Wilson, Barrar, & Fung, 2007). Taking a classroom focus is important in making learning relevant to teachers' practice. High quality professional learning opportunities that can help teachers deepen their knowledge and change their instructional practices generally incorporate three key areas of focus: subject matter knowledge for teaching, how students learn that subject matter, and how to represent and convey that content in meaningful ways (Borko, 2004; Cohen & Hill, 2000; Putnam & Borko, 1997). Timperley (2008) argued effective professional learning opportunities:

- focus on valued student outcomes;
- enable teachers to acquire knowledge and skills established as effective in achieving valued student outcomes;
- promote deep teacher learning through integrating theory and practice;
- challenge teachers' deeply held beliefs and expectations; and
- provide multiple opportunities to apply new learning.

The classroom focus can include opportunities for modelling, observation, coaching, critique, and reflection (Wilson & Berne, 1999), and the use of inquiry approaches (Timperley et al., 2007). Integrating learning opportunities into teachers' everyday work enables teacher learning to be relevant through applying new learning in the practice setting. Borko (2004) emphasised that meaningful learning is a slow and uncertain process for teachers. Well-designed professional development provides classroom support over a sustained period of time (Desimone, 2009; Putnam & Borko, 2000).

The quality of external expertise available to schools and teachers is a second critical factor in the provision of professional learning and development opportunities that lead to changes in instructional practice and improved student outcomes, and the development of school-based conditions for sustainability (Timperley et al., 2007). A growing body of evidence points to the importance of external expertise in promoting and supporting new learning for teachers (Knapp, 2003; Timperley, 2008). The term 'knowledgeable expertise' has been used to distinguish between traditional models of expertise which focus on management and administration and those that focus on promoting learning that makes a difference to student achievement (Timperley & Alton-Lee, 2008). The primary role of such expertise includes challenging existing assumptions about curriculum, teaching, and learning and presenting new possibilities for professional practice (Timperley et al., 2007). Knapp (2003) pointed to the identification of expertise as an issue for consideration by policy makers in relation to professional development initiatives, with resource implications particularly where expertise is lacking.

In the New Zealand context there is increasing evidence of the need for approaches to professional learning that challenge teachers' beliefs, expectations, and deficit theorising in order to raise their expectations of student achievement (Bishop et al., 2009; Phillips, McNaughton, & MacDonald, 2002; Timperley & Alton-Lee, 2008). In discussing the qualities of professional communities that promote teacher and student learning, Timperley et al. (2007) associated the involvement of external expertise with effectiveness and more challenging dialogue. They noted that "all studies of professional communities that did not lead to improved outcomes for students lacked external input" (p. 203). In their consideration of professional development design, Starkey et al. (2009) highlighted the importance of external expertise at all stages of implementing an educational reform. In their study, teachers identified the important characteristics of facilitators as "having strong persuasive and conflict management skills as they met resistance to change, and [the ability] to cater for a wide range of conceptual understandings" (p. 187). Similarly, Timperley and Parr (2009), in their analysis of the New Zealand literacy strategy, identified the key role of facilitators in working with teachers to interpret policy for enactment in classrooms.

Background to the Development of the Project

The imperative to raise student achievement through improving teacher knowledge and practice in New Zealand mirrored the focus of other English-speaking Western countries such as Britain and Australia. The *Third International Mathematics and Science Study* (TIMSS) (Garden, 1997) identified the achievement of New Zealand students as being significantly below the international mean. The Mathematics and Science Taskforce (Ministry of Education, 1997) highlighted a number of overriding priorities for improving mathematics, recommending an initial focus on school-based professional development for teachers of the 5- to 9-year-old age group in the area of number concepts, followed by algebra and measurement. In their investigation of effective teachers of numeracy in the English context, Askew, Brown, Rhodes, Johnson, and Wiliam (1997) also highlighted the importance of teachers' connected conceptual mathematical knowledge. Meanwhile in Australia a state-wide school-based initiative of the New South Wales Department of Education and Training (1998), the *Count Me In Too* project, focused on improving the teaching of mathematics in the early years of schooling. *Count Me In Too*, particularly its Learning Framework for Number and the Schedule for Early Number Assessment, was based on Wright's (1998) work on a mathematics recovery programme and his number framework for assessing and teaching early number. *Count Me In Too* demonstrated successful outcomes in terms of improving teacher knowledge and student achievement (Bobis, 1999) and led to the implementation of a pilot in New Zealand in 2000. The professional development model adopted in this project was school based and involved consultants working with teachers in classrooms.

The initial approach to professional learning adopted in the New Zealand Numeracy Development Project was also school based, drawing on the design of the *Count Me In Too* project. Individual teachers received an allocation of non-contact time to carry out the diagnostic interviews (Ministry of Education, 2008a) of students in their class at the beginning and end of the fifteen-week professional development programme. Every full-time facilitator worked with approximately 90 teachers each year. The evaluation and research findings from the *Count Me In Too* pilot project (Thomas & Ward, 2001) and the *Years 4-6 Numeracy Exploratory Study* (Higgins, 2001) were used to refine and further develop the approach to professional learning adopted in 2001. Important features supporting the focus on professional learning, with the aim of improving student achievement through responding to the tracking of student data, included: classroom-focused professional development (providing opportunity for teacher learning); modelling, observation, coaching, critique, and reflection (supporting change in teaching practice); school-based/cluster workshops and the involvement of professional leadership (building school capacity and professional community); and building facilitator capability (ensuring access to high quality external expertise).

The New Zealand Numeracy Development Project approach to professional development was organised around a set of pedagogical tools and professional learning elements that were designed to convey both the project's core ideas and interconnections between the ideas. The aim of the design was to avoid superficial change to teacher practice by promoting deep learning and complex pedagogy generated through simultaneous attention to aspects of teacher knowledge and to the context of teachers' practice.

The pedagogical tools, the first key component of the design, included the number framework (Ministry of Education, 2008b), the diagnostic interview (Ministry of Education, 2008a), and the strategy-teaching model (Ministry of Education, 2006). Used together, they ensured a focus on the three strategic objectives of the professional development model: improving teacher knowledge of mathematics; enhancing understanding of how students learn mathematics; and enhancing understanding of how to represent mathematical concepts. Teachers learning about, and using, these tools in the context of their own classrooms reflected a situative view of cognition (Bobis, 1999; Borko, 2004; Putnam & Borko, 1997). The first pedagogical tool, the number framework, informed by Wright's (1998) work, is a diagrammatic representation of increasingly sophisticated stages of mathematical thinking, set out as a learning progression for pedagogical purposes. A goal of the Numeracy Development Project was to promote students' part-whole thinking, because counting-based strategies limit the development of students' mathematical thinking (Young-Loveridge, 2001). The second pedagogical tool, the diagnostic interview, also drawing on Wright's (1998) work, was designed so that teachers could identify students' mathematical knowledge and strategies as detailed by the number framework. An important function of the interview was to develop teachers' expectations of their students' learning. The third pedagogical tool, the strategy-

teaching model, drawing on the work of Pirie and Kieren (1992), set out increasingly sophisticated representations of problem-solving strategies. The recursive model distinguished between using materials, student imaging of the problem, and abstractions using number properties, showing that each time new ideas were encountered the sequence of materials, imaging, and abstracting should be used. The model was designed to be used with the number framework and diagnostic interview as an interconnected whole. The three tools played a central role in the professional learning elements.

The second component of the professional development design consisted of context-specific professional learning opportunities structured around the tools, and support for teachers and schools provided by external expertise. The role of the facilitators was to visit each teacher's classroom on three to five occasions over the 15-week intensive development for the purpose of leading teachers' professional learning: first, by demonstrating the diagnostic interviewing of the teacher's students; secondly, by modelling teaching strategies that foster children's mathematical thinking through eliciting children's responses; and thirdly, by observing and providing feedback on teacher practice. The pedagogical tools represented what teachers needed to know and be able to do to respond to students' mathematical learning needs. This paper focuses on the second and third aspects, both situated in a teacher's classroom, that is, the modelling of complex pedagogy and observation of a teacher's practice, and poses the following questions from the facilitator's perspective:

1) How did the modelling of complex pedagogy help teachers to shift their practice?
2) What commentary on the modelling was provided and what issues arose?
3) What was the facilitator's focus when observing teacher practice?
4) How did the facilitator provide feedback on teacher practice and what issues arose?

Data Sources and Analysis

The evidence base used in the analysis focused on eight facilitators from four different regions of New Zealand who were part of a case study examining the efficacy of classroom-focused professional development, and the facilitator's role in supporting school conditions, and leadership that fostered improvement of teacher practice in mathematics. The data source was transcripts of face-to-face interviews with the eight facilitators conducted by one of the authors at the end of the initial phase of the project's implementation. The facilitators were asked questions about what they did when working in teachers' classrooms which included: describing how they went about modelling and observing (such as their overall focus and the resources and tools used); how they managed these two aspects of in-class work, and the challenges they encountered. The facilitators' responses drew on up to four years' experience of working with teachers involved in the Numeracy Development Project. Caution should be

exercised around presenting the facilitator perspective, as this is only one side of the story, with insights from teachers, students, and school leaders also being important. Furthermore, the data reflect facilitators' reports of what they did, rather than their actual actions.

A content analysis (Ryan & Bernard, 2000, 2003) of facilitators' perspectives of working with teachers in classrooms was used to induce themes related to the design features of the professional development that facilitators considered enhanced teacher knowledge and classroom practice. The first stage of the search focused on broad predefined aspects of: the pedagogical tools; the professional development setting of the classroom and school; and external expertise. In the second stage the data within each category were then retrieved and systematically analysed and coded again to draw out key concepts, ideas, and themes. For each theme, key concepts identified as contributing to the development of professional knowledge and practice, and the development of supportive school conditions such as opportunities for teachers to discuss their practice were identified, coded, and categorised. The quotes used throughout the findings section that follows were selected to provide illustrative examples of the themes identified.

The facilitators' interview responses were analysed with the assistance of QSR International's software package NVivo7 (2006), which supports searching and indexing of qualitative data. Both electronic and manual searches of the data were conducted to lessen the likelihood of missing themes or misjudging their relative importance. Combining inductive with deductive analysis enabled the themes from the data to be analysed alongside themes from previous evaluations and the professional development literature (Miles & Huberman, 1994).

Findings: Changing the Difficult-to-reach Dimensions of Practice

This section explores the nuances in the work of facilitators in classrooms. Locating professional development in teachers' classrooms is a powerful means of changing what Spillane and Jennings (1997) term, the *difficult-to-reach dimensions of practice in mathematics*. As explained earlier, the work in classrooms sat alongside the other professional learning component of the professional development model, the workshops with teachers. Together both components provided opportunities for facilitators to engage teachers in examining the project's core pedagogical ideas and the enactment of these in practice. Their approach to working with individual teachers was shaped by the focus of the task at hand, the context of the classroom and school, and the teacher's knowledge and practice. Of interest were their explanations for their approach to working with teachers in their classrooms and the challenges they encountered.

In the sections that follow, we outline aspects of facilitator practice that they reported as having an impact on teacher practice. Such aspects were underpinned by a focus on student mathematical thinking and how these relate to the number framework. The findings are presented in three subsections: first,

the focus on students' mathematical thinking in facilitators' work with teachers, secondly, the structured approach based on the pedagogical tools, and thirdly, facilitator modelling and observation of teachers that enabled a focus on classroom discourse. In the following sections the pedagogical tools and the facilitator's actions are treated separately; however, in practice, what the facilitator did as encapsulated in the pedagogical tools was intertwined with how they worked with teachers.

a) A focus on students' mathematical thinking

> So when I say to the teacher, "What's six and four?" and she says, "Ten" that's not the end, that's the beginning. "So what's the next question you're going to ask?" So if the teacher already knows that, then should I be saying, "What's 60 and 4?" or "What's 16 and 4?" or "What's the connective question?" If I say to the teacher, "What's six and four?" and she says "Nine", what's the question you've got to ask? What are the materials [you're going to use]? What's the scaffolding? (Facilitator 2)

Attention to developing students' mathematical thinking through targeted questioning is evident in Facilitator 2's explanation of her classroom coaching of a teacher prior to their teaching of a lesson. The quote illustrates the complexity of a facilitator's work in classrooms that included mapping out a sequence of questions, considering the materials that suit the mathematical idea, and how to respond to any errors and misconceptions that might arise.

Facilitators explained how they worked with teachers to refine their questioning to reveal the complexity of students' thinking underlying their explanations, for example: *How do we ask the questions to get the kids doing the thinking? … That's my main aim when I'm in the classroom, is to show the teachers how I let the kids do the thinking* (Facilitator 4). The key actions of facilitator modelling and facilitators' observation of teacher practice, which are examined in more detail in later sections, attend to both the quality and extent of questioning and were seen as the main way of creating teacher change: *It's the children talking about what they're doing that's creating the teacher change* (Facilitator 2). In general, promoting more sophisticated mathematical thinking as encapsulated in the New Zealand Number Framework was reported by facilitators to be at the heart of their work in classrooms: *I think this is the crux of the whole programme, if the teachers can get the kids to do the thinking* (Facilitator 4). Retaining the focus on student thinking was challenging. Fore-fronting student thinking so that it drives the lesson rather than enacting a pre-planned sequence is challenging because it requires changes to teachers' knowledge and beliefs about teaching mathematics and mathematics as a discipline, as well as assuming their mathematical content knowledge and their skill in managing classroom processes: *I use a very simple, one-off quote, which I talk about with them all the time and that is that "The child's response is the start of the teaching"* (Facilitator 2).

While these facilitators' comments are representative of all those interviewed, differences arose in the approaches they took in working with teachers to achieve the goal of getting students "to do the thinking". Echoing the

sentiments of all the facilitators interviewed, Facilitator 1 talked about the factors involved and the actions she took to increase student participation. Using the phrase *the dynamics in the classroom*, she explained her focus was *to get them to think, have they only got one child doing the thinking or everybody doing the thinking? … How are they getting maximum participation in their classroom?* The issue of developing teachers' content knowledge is a theme that came up in discussion of different aspects of facilitators' work with teachers. One concern related to the focus on student thinking was that a teacher's content knowledge should be sufficient to enable them to ask a range of questions. Facilitator 1 explained, *I make sure that [teachers] are very confident with the content and I want them to have as many of the students talking and thinking as possible about any question that they ask.*

The focus on students' mathematical thinking reflects a shift in pedagogical practice from a procedural to a conceptual approach and emphasises the interconnectedness of key mathematical ideas – a fundamental objective of the professional development programme (see Higgins & Parsons, 2009). The facilitator quotes above show that this focus was considered by them to be central to their work in teachers' classrooms. Also central to facilitators' work is the use of the number framework, the diagnostic interview and strategy-teaching model, which they employed to structure their approach.

b) A structured approach

This section now turns from presenting the focus of a facilitator's work to discussing the structures underpinning their approach, specifically the use of the number framework first introduced to teachers in the workshops. The categories of knowledge identified as important for teaching (Ball, Thames, & Phelps, 2008) are embedded in the design of the three pedagogical tools of the Numeracy Development Project – the number framework, the diagnostic interview and the strategy-teaching model. These interrelated pedagogical tools are predicated on the idea of increasingly sophisticated ways of thinking about number with the framework laying out these stages, the diagnostic interview suggesting ways of assessing them, and the strategy-teaching model setting out a progression from using materials, to imaging, to using mathematical principles for representing these ideas.

Facilitators introduced the framework in the workshops to groups of teachers, and then used it to structure their work in a teacher's classroom. Facilitator 7 explained that by using the framework as *a reference point* for tracking students' progress: *teachers have got that structure so they can go back to the framework and they can look at where the kids started and then look at the journey they've taken.* Facilitator 2 found it useful for highlighting connections between mathematical ideas. To do this she formatted the framework onto a card that teachers could use as a *ready reference*, and reported that seeing the whole framework on one piece of card enabled teachers to see the connections. *They're not saying I'm planning for this one … and then just going looking for activities; they're looking at what makes the understanding of that piece there*. Facilitator 8 used the framework to inform teachers' interpretations of students' explanations: *listening*

to what the children are saying and being able to think about what that means in terms of the framework. She suggested that this is *where we want the teacher to be at, so that they go from being very reliant on books and reading them as a sequence of instructions*. Facilitator 4 commented: *I think the whole thing really goes back to the framework because without the teachers being able to understand the framework and what actually happens in each stage, the modelling is totally useless.*

The diagnostic interview as a tool for assessing student knowledge and strategies in relation to the framework was useful to facilitators in the context of their classroom work in motivating teachers to develop more sophisticated questioning of students. Facilitator 7 talked about how conversations with teachers indicated their awareness of *the real power of the diagnostic interview* by indicating to him that they liked to re-interview their students because they were *getting to know what the test is all about, getting to know how to question their kids successfully*. On asking them why they wanted to do it again, one teacher told him, *Because I could have prompted [the students] by asking this*, and another teacher said to him: *I wanted to find out how far they'd go backwards*. Facilitator 8 commented that it was important to *take that step away from relying on the diagnostic interview* so that a teacher learned *to make those judgments with a little less support and really focus on what each strategy stage means.* The third pedagogical tool, the strategy-teaching model, was reported by facilitators to be useful for providing a focus in their modelling to teachers: *What I'm really trying to get across is for the teachers to be able to see in their mind what we're talking about when we talk imaging and what we're talking about when we talk number properties* (Facilitator 6). Another facilitator commented: *It's such a huge change in teaching pedagogy that I think this teaching model is something that's got to be revisited several times, along with the framework, to actually make the links as to where the children's pathway of understanding is going* (Facilitator 5).

Elsewhere (Higgins & Parsons, 2011) we have discussed the challenges of ongoing adjustments to the tools that arose from the framing of the Numeracy Development Project as a dynamic approach to the policy process. The intent of the design of any tool will be mediated through its use by facilitators and teachers with variations arising from, for instance, the facilitators' and teachers' mathematical knowledge, contextual nuances across classroom settings, and the types of tasks and their execution.

c) Facilitator modelling and observation of teachers

The third section examines the specific actions facilitators undertook when working in teachers' classrooms. Facilitator 5, in the quote below, sets out these actions in terms of the support role of a facilitator in general:

> [The role of the facilitator] is to support the teacher, to encourage the teacher, to work alongside the teacher, to answer their questions, to foster an environment where they can take risks, where they feel free to ask questions, to provide extras for them that they request – it could be demonstrating the use of equipment. (Facilitator 5)

To undertake the role as described by Facilitator 5 the specific classroom actions centred around modelling and observations. The analysis identified typically four opportunities for a facilitator to mediate the core pedagogical ideas of the project – the modelling, the commentary about the modelling, the observation, and the associated feedback. How facilitators distinguished between these actions varied across those interviewed for this study, from some seeing each action as having a discrete focus, to others seeing actions having a simultaneous focus on both modelling and observation. For the purpose of this discussion, each focus will be treated separately in examining facilitators' reports of what they did, and their rationale for the approach taken.

Before discussing how facilitators worked with teachers, it is also important to note facilitators' orientation to working in someone else's space. All the facilitators talked about building up trust with the teachers with whom they were working. Typical of their comments: *It's just getting to know the teachers and getting to know what motivates them and establishing that rapport with them* (Facilitator 6) and *I think there's more to that in-class stuff than just modelling. I think that's where you build up a lot of rapport with teachers* (Facilitator 4). Putting modelling for the teacher rather than observing the teacher as the first thing they did in the teacher's classroom was advocated by some facilitators: *The first one I don't do any observation at all, part of the thing for me there is to put them at ease, I want to wow them* (Facilitator 6). These comments suggest that important to facilitators' work was generating relational trust helpful to promoting change in teacher practice through modelling with associated commentary and observation with associated feedback.

i) Modelling ambitious pedagogical practice

In the modelling, facilitators taught students while the teacher watched. Three sets of variations to the modelling were evident: first, what was modelled; secondly, when the modelling occurred in the professional development sequence; and thirdly, how the teacher was included. Facilitators regarded the modelling as a powerful component of the professional development because it showed the teacher what their students were capable of when using the pedagogies promoted in the Numeracy Development Project:

> I think the modelling in the classroom is just so much more powerful [than the demonstration in the workshop] because you're doing it in their surroundings, you're doing it with their kids and I think sometimes they sit in the workshops and think that's alright for her, she hasn't got my kids, but when they actually see us in there, a) managing their kids and, b) using the equipment, I think that it's quite powerful. (Facilitator 4)

With the overall purpose of the project being to use students' explanations to develop their understanding of number concepts, facilitators varied in whether they modelled complete lessons that were part of the students' learning programme or whether they modelled specific aspects of numeracy teaching aimed at developing students' mathematical thinking: "So we're more modelling

and talking about the actual components of the effective teaching on the way rather than teaching the children the lesson (Facilitator 2). One facilitator explains her reasons for not modelling using a lesson format: I'm doing a lot more things than I would do in a normal lesson with the kids (Facilitator 6). Another facilitator saw the modelling as: actually making them aware of the expectations (Facilitator 7).

Facilitators distinguished between modelling knowledge teaching and modelling strategy-teaching and considered that it was important when first working with teachers that they included modelling of both: *So when I'm first going in to model I'm looking at modelling knowledge and addition and subtraction strategy* (Facilitator 6). One facilitator saw the modelling of knowledge and strategy as an opportunity to challenge students: *Each time I come in with the kids I raise the bar, I do some knowledge teaching, then the strategy-teaching* (Facilitator 7). Several facilitators interviewed described their purpose in modelling strategies, one commenting: *I want [the teachers] to see my strategy modelling, … to see the kids doing things, that they say, "Oh my goodness I had no idea they could do that"* (Facilitator 6).

In modelling strategy-teaching, questioning of student thinking was a consistent focus in facilitators' descriptions of their modelling: *Teachers really appreciate the fact that you are asking the kids questions in such a way as the teachers have got to reflect about what they're doing and they've got to take risks* (Facilitator 7). Facilitators used the questioning of students to change teachers' expectations of students:

> A teacher was saying to me the other day, he said, "You just don't take no for an answer, you don't take a shrug of the shoulders, you don't take a wag of the head", he said, "You just wait" and he said, "They're just looking at you and you're waiting and you're waiting and then they realise they've got to do some thinking", he said, "I never wait that long". (Facilitator 7)

Facilitators also talked about the times that their modelling did not go smoothly and their focus on the goal of promoting students' mathematical thinking slipped their attention: *Doing some of the strategy-teaching I caught myself actually … telling the kids what to do* (Facilitator 4). When this happened, one facilitator commented that it was an opportunity to show that you could be wrong:

> I even know with your own modelling when you're tired and things don't go right and actually it's probably a good thing to model … I'm allowed to be wrong myself…to encourage that with children …children are allowed to be wrong and that you accept all answers. … Yeah, of course you have disasters yourself, I mean in one lesson I've gone, "Oh, we'll just flag this, let's try something else". (Facilitator 3)

One facilitator, in reflecting back over the initial four-year period of the project's implementation, commented, *In terms of modelling for teachers and observing, it's changed fundamentally and the principles behind why I'm doing what I'm doing*. She explained how modelling was accepted as being part of the design of the work with teachers. She described their approach: *We were quite novice … about our*

actual modelling techniques, so we tended to teach one-off specific items and then talk with the teacher about what it was that we've done. She contrasted this with how it had changed: *The modelling that we're doing now is completely different in that it's structured around a concept rather than a specific activity or an idea* (Facilitator 2). However, the shift to structuring the model around a concept rather than an activity generated different challenges for facilitators to consider, including when and how to model both knowledge and strategy-teaching, and how to focus teachers on the critical aspects in the modelling. As summed up by one facilitator:

> So the real skill [of a facilitator] is to be able to do the bits that are really important, so you've got to say to yourself now, what are the important things at this stage that you want these teachers to be able to do, so that then they're going to use that equipment and use those questioning skills to elicit the right responses from the children, and what I think has been really hard is a) we've got an awful lot of equipment and b) we've got to think now what is it that's the most important thing for them to actually see you modelling. (Facilitator 4)

ii) Providing commentary on the modelling

Facilitators identified two different opportunities for talking with teachers, one at the end of the modelling and the other during the modelling:

> Having that discussion with the teacher after is really important about the pedagogical side of what you've done, looking at a strategy focus and developing those ideas of where the children are, what we could tell by their responses and talk about some of the pedagogical aspects that I might have modelled. (Facilitator 8)

Most of the facilitators in their first year of working on the project talked with teachers at the conclusion of the modelling. However, by their fourth year on the project they reported shifting their practice to delivering a running commentary for teachers during the modelling. While facilitators do need to select the bits that are really important and ensure that they model these for teachers, facilitators also need to explicitly guide teachers to notice the important things. In providing a commentary while they modelled, facilitators reported being able to draw teachers' attention to the underlying mathematical principles of the ambitious pedagogical practices. Facilitators considered their commentary on what they were modelling to be a powerful aspect of their in-class work with teachers.

Providing a running commentary also gave facilitators an opportunity to highlight to teachers key aspects of pedagogy: *So I'm talking to the teachers all the time when I'm modelling, "Can you see such and such and do you notice?"… Because I find if I don't, they don't see the things I want them to see* (Facilitator 6). One facilitator talked about the time she spent in *orienting the teacher to what it is that they're looking at and this is what I'm going to be saying and this is the way that I think that this will happen*. She explained how she took *more breaks in between to talk with them on the way so we don't debrief afterwards, we debrief all the way through with the children there* (Facilitator 2). Yet another facilitator described this process as

having *double cognitive layers that are sitting there in terms of when I'm modelling I'm actually unpacking with kids, but I'm also unpacking with a teacher* (Facilitator 7). They reflected that when modelling previously they had not *really been aware of the layer that I need to talk with the teacher so that I can help them sort out where the kids are at* (Facilitator 7).

The modelling also created challenges for both facilitators and teachers because the students were present and the commentary to teachers was intended to exclude student participation: *My modelling's not for the kids, it's for the teachers* (Facilitator 6) and *I no longer say to the teachers I'm here to teach the children, I'm there to teach them* (Facilitator 2). Facilitators mentioned that they adjusted their commentary: *Yep I'm being careful about the sort of talk I'm using* (Facilitator 6). The teacher's dual role of both teacher and learner can create potential issues for the teacher; however, one of the facilitators commented that she did not see this as an issue: *The children are seeing the teacher as the learner and this is ok, this is what they're practising* (Facilitator 2).

A central component of the commentary was having the reference point of the framework, by for instance saying to them: *"Let's look at the framework … So what sort of things does he need to do?" and immediately the teachers are feeling, "Hey, I know I've got a way forward"* (Facilitator 7). Another facilitator relayed how she drew teachers' attention to her questioning: *Hey, just think about that question that I asked then, so it's just trying to tune them into thinking "Why did I ask that question?"* (Facilitator 4). One facilitator used a debrief sheet to focus the teachers away from the surface features of the tasks such as, She played cards and She asked the kids this to what she termed going from surface to deep to the focus being… *It's about "What did you see?" "What would you do differently? "What would you do with these children next?" So there are structured questions that look at the underlying, deeper principles* (Facilitator 2).

Not only were there challenges in getting teachers to notice the right things, but also challenges in delivering the modelling to teachers that included deciding on the instructional configuration – the whole class or a strategy group? Sometimes this was to do with the orderliness of the class. As one facilitator commented: *it comes back to the management techniques, modelling only works if the rest of the classroom are quiet and everything, the ideal situation* (Facilitator 3). One facilitator's response to this was instead of modelling with a group, they decided to model with the whole class. One nuance of teaching the whole class – when the practice promoted in the Numeracy Development Project at the time was grouping students by strategy stage for instructional purposes – was where to pitch the modelling of specific strategies, for example showing imaging, promoting mathematical properties:

> Sure there's some kids that are not with you. ... I used to do it in groups, but I found that it didn't work too well because the teacher tended to actually watch the other groups rather than watch what I was doing and so I found by going back to whole class …while it was stressful on you, the teacher was actually getting a very good idea of what to expect and what kind of things to do with the kids. (Facilitator 7)

iii) Observation

The observation aspect of the professional learning comprised the teachers teaching their students, either the whole class or a group, while the facilitator watched. The purpose of the observation was to provide the teachers with an external expert's perspective on their classroom practice. The facilitators observed lessons "in action", rather than commenting on video-recordings of lessons. They noted their thoughts using informal field notes for the purpose of providing oral feedback to the teacher at the conclusion of the lesson. Two sets of variations to the observation were evident from the interview data: what was observed; and when the observation occurred in the professional development sequence.

The focus of the observation was on how teachers question students, how they use mathematical representations, and how they judge the sophistication of students' mathematical thinking while they're teaching. The observation of the lesson took place after the facilitator's initial modelling which, as mentioned before, they also used to build trust and rapport with teachers. In some cases, the lesson directly followed on from the facilitator's modelling in terms of both timing and content as explained by one facilitator: *Now generally what happens in the second or third follow-up visits … is that we have an arranged time where I do something and she does something and then together we reflect* (Facilitator 7). One facilitator related how she based the observation on *the criteria of dynamics in the classroom* with her reference point being *quality numeracy practice*. She explained that with this general focus she could say things like: *Yes it was wonderful to see that you are using the equipment, that the written recording is flowing on really well from that child's speaking of it, that your language was really precise, that you had partner talk* (Facilitator 1). However, facilitators were not in agreement about what the focus of the observation should be or who should set it. Some facilitators asked teachers for guidance on what they would like observed: *Ideally when I'm doing observation I'll get the teacher to tell me what they would like me to give them specific feedback on* (Facilitator 8). Another suggested that rather than doing *a blanket observation on something* she undertook a process of negotiation, *I let them choose first, but by my questioning we get to something that I believe and they believe is going to help them when they're delivering [the Numeracy Development Project] and then something that I can give specific feedback on* (Facilitator 4).

iv) Providing feedback on teachers' classroom practice

Facilitators' feedback to teachers of their observation varied in terms of where it was given, how it was structured, whether it was written or oral, and the extent to which its focus had changed over time from instructional management to mathematics. One facilitator explained how they reflected together with the teachers at the end of the teaching observation: *We reflect with the kids, the two of us are saying, "Well what is the big idea that you got out of that? What's the sort of diary statement? What can we write in our modelling book?"* (Facilitator 7). One facilitator reflected on how her practice had changed from the beginning of the project. *I*

can see now that the kinds of debriefs that we were doing were driven by me, rather than reflective on the teacher and while they weren't a waste of time they certainly didn't get to the underlying issues (Facilitator 2). She explained how her practice now was to *intervene on the spot so the teacher can actually practise that in the next two minutes, not in the next day when you're not there* (Facilitator 2). Her reason for changing to providing on the spot feedback during the observation was: *I don't think they learn it from one debrief discussion. I think they learn it from practising it with help to be able to do it* (Facilitator 2).

Many facilitators were concerned about the form that written feedback should take. One of the facilitators talked of the discussions in their regional team about teachers feeling *very uncomfortable when we've got paper and are writing down notes*. This team worried that written feedback would be *used as a form of appraisal* (Facilitator 5). One member of this team explained how she changed her practice to avoid this happening:

> I write very detailed observation notes and I hand them over to them straightaway. … I used to keep them myself and just talk them through, give them a photocopy if they wanted it … now I actually have gone one step further and said, "This is for you, for your support, here they are and I haven't got a copy" … At the end of the sessions I don't have any record, except a memory in my head, but it feels quite good to be doing that. (Facilitator 1)

Another member of this team addressed the concern of notes being used for appraisal purposes and so being potentially threatening to teachers: *I want to talk about what's actually happening and model what the next step is and my theory is that if I give it to them in a reasonably scribbled form they don't feel so threatened about it* (Facilitator 4). She goes on to explain how she uses the number framework to structure her feedback: *Often I'll scribble out the framework, so I'll put the little boxes and I'll say, "Ok, now what goes in there? Now where have you got these children?" It becomes very clear where the next step is.* This same facilitator explained how she also focused on the core idea of the project, that of promoting student thinking:

> So as soon as something happens in a lesson where they've actually done the thinking for the kids, I'll scribble a wee note down and then I'll try and come back to that at some stage and some of them even say it now before I get there, because they'll say "Oh I did the thinking for them". (Facilitator 4)

The previous sections have highlighted four different opportunities through which facilitators can influence the *difficult-to-reach* dimensions of individual teachers' practice. The focus on student thinking was structured by the use of the pedagogical tools and enabled facilitators to attend to substantial aspects of pedagogical practice. However, it is also important to note that this work in classrooms presents challenges that include the facilitator's simultaneous focus on the teacher's as well as the students' learning. Even with an approach structured by the pedagogical tools and professional learning tasks and located within the classroom, challenges arise.

Challenges and Opportunities

The preceding account of the complex and nuanced nature of facilitators' work in classrooms highlights the pivotal role of external expertise in education reform that seeks to influence the *difficult-to-reach* dimensions of teacher practice and improve outcomes for the diversity of students in our classrooms. Effective external experts need an integrated understanding of relevant curricula, and effective assessment practice and curriculum-specific pedagogy. They need to be able to make new knowledge and skills meaningful to teachers and manageable within their practice contexts, to connect theory and practice and develop teachers' ability to use inquiry and assessment data to inform their teaching decisions (Timperley et al., 2007). In the Numeracy Development Project, the facilitators who are the focus of this article adopted a range of key approaches as they worked with teachers in classrooms. The pedagogical tools provided a common frame for their work by embodying the key ideas of the project, and the professional learning approach was variously interpreted through being contextualised by teachers' practice settings and facilitator expertise.

The shift in the focus of policy research to the sites of implementation, in particular, classroom, school, local and regional levels of schooling, has highlighted the need for education policy makers and reformers to pay attention to the relationship between policy and practice (Cohen, Moffitt, & Goldin, 2007). Those involved in the policy implementation process mediate the effect of policy (Coburn, 2001, 2006; Cohen, Raudenbush, & Ball, 2003). Various authors have identified the important influence of contextual factors on the change process and the agency of teacher educators, professional leaders and teachers in interpreting policy direction (Datnow & Park, 2009; Spillane, Reiser, & Reimer, 2002). Increasingly, the implementation process is viewed as an active interpretive process in which the role of those who mediate policy is as important as the role of those who formulate policy (Coburn, 2006; Datnow & Park, 2009). The role of external expertise in policy implementation – in particular, working with teachers to interpret policy for enactment in classrooms – is therefore critical (Starkey et al., 2009; Timperley, 2009; Timperley & Parr, 2009). Early on in the Numeracy Development Project, Higgins (2005) identified the importance of the pedagogical approach adopted by the facilitator in helping teachers implement new teaching practices aimed at improved student outcomes. In comparing two orientations to facilitation – a contextually responsive approach and a design adherence approach – Higgins concluded that a contextually responsive approach focused on "students' strategies, meaningful activities and multiple representations" in which "students' understanding and thoughtful investigation is paramount" (p. 142). Such facilitation expertise is necessary to achieve deep and consequential change in classroom practice.

The New Zealand Numeracy Development Project has significantly influenced classroom practice and lifted student achievement in English and M?ori medium settings. However, despite some initial reduction in achievement disparities for Maori and Pasifika students, this improvement trend has not

continued. National and international monitoring data from assessment studies show that disparities in achievement for these groups of students remain.

The Best Evidence Synthesis Effective *Pedagogy in Mathematics/Pāngarau* (Anthony & Walshaw, 2007) highlighted the complexity of effective mathematics teaching and the sophisticated knowledge and expertise in teaching mathematics needed by teachers, in particular, in primary schooling. In the New Zealand context, teacher dispositions and expectations about student potential, and capacity to respond to cultural and linguistic diversity, are also important in the provision of learning opportunities through which all students can achieve success in mathematics.

Recent research in the New Zealand context has increased our understanding about the expertise required to facilitate the process of change in teacher practice that lifts outcomes for Maori and Pasifika students. Hunter (2007, 2008) documented two cases in which teachers changed their practice so that they were able to provide challenging and equitable opportunities to learn for the students in their classes. These teachers supported their students to work collaboratively in engaging with important mathematical concepts and developing the skills of mathematical reasoning and argumentation. The professional learning and development approach that was adopted engaged teachers in a collaborative process of inquiry into their practice, supported by a researcher (Alton-Lee, Pulegatoa-Diggins, & Sinnema, 2010).

Hunter's (2007, 2008) work raises the question of what constitutes sufficiency (a combination of quality of support by external expertise, and time) in terms of the professional learning and development provision necessary to bring about sustainable shifts in classroom practice across a system. In discussing the development of an infrastructure for quality teaching that responds to inequality of educational opportunity, Darling-Hammond (2010) identified the need for focused investments in teacher preparation and development and pointed out that:

> A summary of experimental research found that short-term professional development experiences of 14 hours or less appear to have no effect on teachers' effectiveness while a variety of well-designed content-specific learning opportunities averaging about 49 hours over a 6- to 12-month period of time were associated with sizeable gains. (p. 205)

Although adjustments were made to elements of professional development provision during the course of the Numeracy Development Project (Higgins & Parsons, 2011), these may have been insufficient to support teachers to make the shifts in their practice towards responding more effectively to the diverse learning needs of all students in their classrooms.

Through an examination of the role of external expertise – in this case the numeracy facilitator – in the provision of classroom-focused opportunities to learn for teachers, this article raises another important challenge for education policy makers and reformers in the design and implementation of successful system-wide professional development initiatives. The challenge relates to how

to build the capability of external expertise that can work alongside teachers in ways that engage them in substantive new learning and practice. How do facilitators develop the adaptive expertise needed to work in contextually responsive ways in classrooms? How does a system best sustain an effective cadre of in-service teacher educators/facilitators so that schools and teachers have access to sufficient external expertise? This challenge is an important area of investigation for the education research community.

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