Australian Journal of Teacher Education

Volume 38 | Issue 7 Article 7

7-2013

Enriching the Professional Learning of Early Years Teachers in Disadvantaged Contexts: The Impact of Quality Resources and Quality Professional Learning

Elizabeth A. Warren

Jodie Miller
Australian Catholic University

Enriching the Professional Learning of Early Years Teachers in Disadvantaged Contexts: The Impact of Quality Resources and Quality Professional Learning

Elizabeth Warren
Jodie Miller
Australian Catholic University

Abstract: Studies indicate that very few teachers entering disadvantaged contexts feel prepared academically or professionally to teach effectively. This study focuses on the impact of a model for professional learning, the RoleM Professional Learning model (RPL), situated in a disadvantaged context over a three-year period. The participating teachers (n = 12) in this study taught in the first three years of school (Foundation to Year 2). To ascertain the effectiveness of RPL, teachers were interviewed three times a year and students' pre and post-test scores were also considered. The results indicate that quality teaching is related to the establishment of quality resources and quality professional learning. Additionally, students demonstrated significant gains between the pre and post-test scores. Furthermore, as teachers move towards exhibiting the characteristics of expert teachers they progress through five stages and it takes at least two years for this progression to occur.

Introduction

Education is seen as crucial for students from disadvantaged contexts. It is a significant factor that allows these students to participate in mainstream society, access employment (Lamb & McKenzie, 2001) and further education (Zappala, 2003). In Australia, the education outcomes of students living in these contexts remain lower than other Australian students (Gonski et al., 2011). In addition, it has been evidenced that students from these contexts begin school with a lower knowledge of mathematics than their peers (Griffin & Case, 1997). This finding is not attributed to their ability but rather to the experiences they have had prior to school, especially with regard to school mathematics. There is also strong evidence that an understanding of mathematics at an early age impacts on later mathematical achievement (Aubrey, Dahl & Godfrey, 2006). Thus, building strong foundations for students from disadvantaged contexts is crucial. While we acknowledge that many outside school factors contribute to these disadvantaged students being unsuccessful, quality learning is associated with quality teaching (Hattie, 2009; Smart, Sanson, Baxter, Edwards, & Hayes, 2008). RoleM (Representations, Oral language and Engagement in Mathematics) is a four-year longitudinal study situated in the first four years of schooling in some of the most disadvantaged contexts in Queensland. This paper draws on the experiences of one participating school, Dragon school over their three-year long participation with RoleM, a school that has achieved outstanding numeracy gains for their students. This study aims to explore how quality professional development and the provision of quality resources can begin to support quality teaching.

Background

Dragon school, a Foundation – Year 7 school, is situated in a low socio-economic area of a large metropolitan city, and consists of students from culturally diverse backgrounds. Its Index of Community Socio-Educational Advantage (ICSEA) is approximately 900, 100 points below the state average. The ICSEA score for each school reflects the occupation and education of parents/carers, the socio-economic characteristics of the areas where students live, the proportion of students from language background other than English, as well as the proportion of Indigenous students enrolled at the school (ACARA, 2013). Dragon school comprises 450 students of whom 14% are Indigenous and 66% come from a language background other than English (ESL). Australia is a mono-linguist culture where the vast majority of people only speak English, and English is the language used in nearly all school contexts. In addition, all Year 3, 5 and 7 Australian students sit for an annual literacy and numeracy test (NAPLAN). Over the three years of Dragon school's participation in RoleM, their Year 3 NAPLAN numeracy scores changed from 339 (350) to 368 (366) to 380 (360). The figures in brackets are the 'similar school scores' for each year (ACARA, 2013). The Year 3 NAPLAN numeracy scores for all schools (the national average) for these three years were 395, 398 and 396 respectively. On average Dragon School scores are 30 points below the 'all school' scores.

Disadvantaged Australian Contexts

Traditionally disadvantaged contexts in Australia have been identified as contexts where there are high levels of unemployment and those that are employed tend to be on low incomes. But living below the poverty line does not necessary mean that one has low standards of living. 'Poverty line measures tend to belie the complexity and scope of disadvantage' (Price-Roberson, 2011, p. 2). Recently, there has been an acknowledgement that these indicators are simplistic and community disadvantage is denoted by a complex cluster of factors, including unemployment, low educational level, and drug and alcohol abuse (Price-Robertson, 2011). Community disadvantage also is defined by its social and environmental factors such as weak social networks, poor role models, and relative lack of opportunity (Edwards, 2005; Vinson, 2007).

Schools in disadvantaged contexts share four common traits:

- They tend to be situated at the lowest levels of a variety of performance measures (e.g., National and International tests of literacy and numeracy performance);
- They commonly possess poor management and poor performance practices (Lupton, 2004);
- They have high staff turnover, and experience difficulties in attracting and retaining high quality teachers (Lyons, Cooksey, Panizzon, Parnell & Pegg, 2006); and
- The teachers they tend to attract are inexperienced and lack a commitment to teaching in these contexts (Heslop, 2011; Mills & Gale, 2003).

Low-income and minority students internationally seem to be disproportionately taught by underqualified teachers (Borman & Kimball, 2013). Thus maximising the mathematical achievement of students and supporting quality mathematical teaching in these contexts is complex.

Teaching Mathematics in Disadvantaged Contexts

Studies have shown that very few teachers entering these contexts feel prepared academically, culturally or professionally by their pre-service education to effectively teach disadvantaged students (Lyons et al., 2006; MCEECDYA, 2011; White & Reid, 2008). In addition, due to the population demographics of Australia and the location of disadvantaged communities, many of these teachers feel professionally, socially and geographically isolated. Furthermore, mathematics is a subject area where many early teachers feel unconfident teaching (Warren, 2009). Many are often unable to create highly effective instructional programs (Kent, 2004). Thus, mathematics teaching in these contexts is often highly structured and repetitive with a high reliance on worksheets and lowered expectations with regard to student learning (Hewitson, 2007). Teachers in these contexts posses few resources or have mentors to assist them to be effective. Yet, Gervasoni et al. (2010) assert that providing rich learning environments with specialised instruction for students in these contexts is imperative to improving their mathematical learning outcomes. Hence, maximising the mathematical achievement of students in these contexts consists of addressing two main dimensions, namely, (a) providing quality mathematics resources that support these students learning and (b) assisting teachers in these contexts to implement quality instruction.

Quality Mathematical Resources

Underpinning the development of the RoleM mathematical resources to be used in these contexts was a recognition that:

- Students learn in a variety of ways;
- Classrooms have students with a variety of learning styles who are at different stages in their learning of mathematics;
- Student engagement is closely associated with student learning;
- Classrooms in these contexts are often poorly resourced;
- Teachers often have pre-conceived beliefs that these students are incapable of engaging in the main-stream curriculum; and
- Teachers are professionals with an understanding of what works and what does not work in their classroom contexts.

The principles of equitable teaching drove the creation of RoleM resources. This required ensuring that the resources are: conceptually orientated, open-ended to cater for the differential that exists in students' ability, of high cognitive demand, and are culturally appropriate (Boaler & Staples, 2008). The RoleM learning activities also encapsulated:

Learning pathways – providing a gradual progression along a learning path, with the teacher first modelling what is required, followed by students of similar ability working in groups and finally students working on an individual basis;

Integrated experiences – Involving listening, reading, writing, recording, manipulating, physically moving, and speaking about the concepts to enhance students' transference of skills;

Multi-representations – Using and linking concepts to a variety of mathematical representations including number lines, charts, concrete, and symbolic;

Language building – Encouraging students to move between home language, mathematical language, and Standard Australian English (SAE) as they communicate their mathematical learning;

Engaging and focussed – Ensuring that the materials were visually stimulating in conjunction with specifically focussed on the mathematical concept under consideration; and

Making connections – Linking resources to other mathematical concepts and to students' home and community environment.

(Frigo & Simpson, 2001; Jackson & Cobb, 2010; Warren & deVries, 2009).

The RoleM resources consisted of purposively developed learning activities, concrete materials, digital materials and assessment tools. These were given to participating teachers three times throughout each year. The teachers were also supported by the RoleM website which aimed to support teachers to differentiate learning for their particular context.

Quality Instruction

The quality of instruction is as imperative to enhancing student learning as is access to quality resources. Effective teachers know what to teach, and how to structure and organise this in the context of their particular students and circumstances (Askew, 2008). High quality lessons are structured and implemented in a way that enhances students' understanding of concepts and engages them in the learning (Weiss & Pasley, 2004). As Hattie (2003) shared, the most effective primary focus for improving students' learning involves augmenting students' affective and academic domains. Thus, high quality lessons are more likely to enhance students' understanding of concepts and engage them in the learning. These lessons also need to be situated in a context that invites students to interact purposively with the content, cater for the level of the learner, and tap into multiple pathways of development (Weiss & Pasely, 2004). Lampert, Beasley, Ghousseini, Kazemi, and Franke (2010) refer to these types of experiences as 'ambitious teaching'. From their perspective ambitious teaching incorporates three main dimensions: first, it supports students to solve cognitively demanding tasks; second, it orchestrates whole class discussions where students build on others contributions to support their understanding of key ideas; and finally, it encourages students to effectively communicate their mathematical reasoning by using and making connections between multiple representations (Cobb & Jackson, 2011). One concern expressed in the literature with regard to these dimensions is the notion of equity (Boaler & Staples, 2008), and the social norms such a vision requires. Thus, it is suggested teachers in socially disadvantaged contexts may need to make some accommodation in order for all students to participate. These include rephrasing and revoicing students' reasoning that may be expressed in informal and non-mathematical language, ensuring students are recognised as mathematically competent, and negotiating how they can participate in all phases of the lesson (Jackson & Cobb, 2010).

Additionally, expert teachers have deep representations about teaching and learning. They have knowledge that is more integrated and are flexible in its use in the classroom. Expert teachers also take ownership of their lessons, changing and adding to them as needs may emerge and goals change (Borko & Livingston, 1989). Professional Development (PD) that supports teachers' professional learning is a powerful influence on assisting teachers to become experts (Hattie, 2003). Hence, professional learning is seen as a key to improving disadvantaged students' educational outcomes. Thus, a strategy that is seen as the most important agenda schools can adopt to raise students' achievement is high quality professional learning for teachers (Hattie, 2009).

Quality Professional Learning

Professional learning is dependent on the interactions that occur between the learner, the context, and what is learned (Gravani, 2007; Jarvis & Parker, 2005, Murrell, 2001). Thus, it happens over a long time, and is a contextualized holistic experience (Vygostky, 1978). Integral to continued professional learning is the notion of the Zone of Proximal Development (ZPD) (Vygotsky, 1978). ZPD is defined as an individual's potential capacity for development through the assistance of a more knowing person (Vygotsky, 1978). The significance of ZPD is that it determines the lower and upper bounds of the zone within which PD instruction and teacher learning should be directed. In the lower bounds, formal PD sessions provide important information that teachers need to know about mathematical content, changes in the curriculum, innovative teaching strategies, and using resources effectively. However, instruction is only efficacious when it goes beyond the notion of simply assisting a person to acquire a particular set of skills or knowledge. Such instruction enables learners to extend themselves through active engagement, exploration and investigation of teaching and learning concepts and activities. In the upper bounds of the ZPD, the 'more knowing person', or 'expert', provides support for teachers through mentoring and scaffolding as these teachers are guided towards competent and accomplished practices (Brockbank & McGill, 2006). A purported result of such a model is that the learner is better placed to independently implement innovative pedagogical practices across all curriculum areas after the 'expert' has withdrawn.

The nature and quality of teacher's reflection influence the depth and scope of learning as much as that of the learner's capability (Phillips, 2008; Wells, 1999). Thus, when extensive teacher reflection is combined with action, students' experiences are transformed into learning (Schon, 1983). Teacher reflection serves both an instrumental and a critical function (van Manen, 1977). The former encourages teachers to reflect on teaching and learning problems that arise in their classrooms, and formulate practical plans that may solve the problem. Reflection as a critical function provides cognitive and affective insights that can challenge assumptions teachers hold about such things as: the nature of teaching and themselves as teacher, and their students' ability as learners in mathematics (van Manen, 1977). As Dewey stated, genuine thinking only occurs "when there is a tendency to doubt" (as cited in Garrison, 2006, p. 3). With ongoing support, teachers and 'experts' become co-constructors of knowledge moving within and beyond each others' ZPD.

Within the scholarly literature the terms 'professional learning' and 'professional development' are often intertwined. From our perspective professional development is a process and professional learning is what teachers gain from the process. Teachers' professional learning is complex. Webster-Wright (2009) claim that 'authentic' professional learning is situated learning that engages teachers to actively work with others to solve genuine problems they experience in their professional practice. Thus effective professional development is continuing, active, social and related to teachers' practice. 'But many PD sessions still remain as updates of information delivered in a didactic manner, separated from authentic experiences' (Webster-Wright, 2009 p. 703), and are decontexualised. Hargreaves (2003) maintains that this type of PD reinforces the divide between theory (what teachers learn at the PD) and practice (what teachers do in their classrooms).

The RoleM Professional Learning Model

The RoleM Professional Learning model (RPL) is a socio-constructivist model based on the theories of Vygotsky (1978), and involves experts and teachers working collaboratively

(Warren & Quine, 2013). Five principles drawn from the literature also underpin the model: teachers' professional learning is more evident when continuing professional development (PD) includes a focus on classroom practicalities (e.g., Porter, Garet, Desimone, Birman & Yoon, 2000); PD emphasising general teachers' knowledge and teaching competencies known to improve student learning, requires teachers to reconsider their current practices (e.g., Timperley, 2008); Professional development is more meaningful to teachers when it is situated within the context of their workplace (e.g., Webster-Wright, 2009); the most significant changes in teacher beliefs and attitudes occur when teachers have multiple opportunities to absorb new information, put it into practices and observe improved student learning outcomes (e.g., Darling-Hammond, 1997); and, resourcing has an impact on a teacher's capacity to effectively teach mathematics (e.g., Clements, 2004). Because of the narrowly perceived idea of Professional Development within the education community at large, we argue that Professional Development days are components of a model that support professional learning. But for effective professional learning to occur, teachers together with experts, need to trial ideas in their classroom contexts and reflect on the student learning that has occurred.

The RoleM Professional Learning model (RPL), a model that supports the professional learning of teachers, involves teachers in self-reflection as they trial approaches and resources in their classrooms to improve the quality of their teaching practice. It is based on the view that teachers have the ability to improve their practice by trialling 'proven' effective learning experiences, and through continuous cycles of on-the-job reflections and discussions with experts from the field (Castle & Aichele, 1994). Briefly, the model is cyclical with each cycle commencing with a professional development day (PD) where activities are presented, modelled, and discussed with a particular focus on implementation in the classroom context. At these days teachers also received the RoleM resources ready for implementation in their classrooms. Teachers return to the classroom and begin to trial ideas. Approximately three weeks after the PD day, experts conduct follow up visits (FV) in each teacher's classroom. At these visits experts and teachers work collaboratively to address any issues identified by each teacher. Teachers then continue to implement the activities in their classrooms. Finally, teachers and experts work together to plan the next phase in students' learning, and the cycle begins again.

The effectiveness of professional development is commonly measured by three different measures, with teacher enjoyment (gains in teachers' affective domain) being the predominant one (Guskey, 2003; Salpeter, 2003). The other two measures are: the professional learning that occurs in the participating teachers (Wenglinsky, 2002), and the consequential gains in their students' learning outcomes (Kent, 2004). Effective professional learning is seen as resulting in changed teacher behaviour, especially in terms of their classroom practice. It is the later two measures that underpin this research, changes in teachers' practices in conjunction with gains in students' learning outcomes. Thus, the particular questions addressed in this paper are:

1. How effective is the RPL in supporting the professional learning of teachers working in disadvantaged contexts?
2. What effect does each progressive year of the school participating in RPL have on teachers' professional learning?
3. What is the impact of quality professional learning on students' learning outcomes?
4. What are the implications for effectively supporting teachers' as they transition in and out of disadvantaged contexts?

Research Design
Sequence of Events

The RoleM Professional Learning model (RPL) was implemented three times each year, with each cycle commencing with a PD at the beginning of term 1, 2 and 3. At the commencement of each year, a pre-test was conducted with all participating students. These tests were developed and administered by especially trained members of the RoleM team. At the completion of each year members of the RoleM team conducted a post-test with all participating students.

Participants

Teacher Participants: For the purpose of this article, the data is drawn from the first three years of the project (2010-2012). In all, 12 teachers from Dragon school participated in RPL over this period. Of these 12 teachers, 4 participated over a two-year period (Teacher D, E, H and I). For example, Teacher D (Year 1 teacher) participated in the 2010 PD (three sessions) and FV (three visits), and in the 2011 PD (three sessions) and FV (three visits). The sample comprised both beginning teachers and experienced teachers. Table 1 presents the participating teachers' year level, their teaching experience, and the PL they participated in.

Teacher	Experience	Year level	Focus of RPL
A	6 years	Foundation	2010 (Foundation)
B	7 years	Foundation	2010 (Foundation)
C	3 years	Foundation	2010 (Foundation)
D	1st year	Year 1	2010 (Foundation) & 2011 (Year 1)
E	7 years	Year 1	2010 (Foundation) & 2011 (Year 1)
F	1st year	Year 1	2011 (Year 1)
G	1st year	Year 2	2011 (Year 1)
H	3 years	Year 2	2011 (Year 1) & 2012 (Year 2)
I	18 years	Year 2	2011 (Year 1) & 2012 (Year 2)
J	2nd year	Year 2	2012 (Year 2)
K	25 year	Year 3	2012 (Year 2)
L	8 years	Year 3	2012 (Year 2)

Table 1: Teacher Experience, Year level, and RoleM Professional Learning conducted over three years

As can be seen from the above table, the sequence for the RPL was 2010 (Foundation year), 2011 (Year 1) and 2012 (Year 2).

Instrument Development and Data Analysis

Semi-structured interviews: Participating teachers were interviewed three times each year. The duration of each interview was approximately 30 minutes and was conducted via telephone by a researcher who did not conduct the professional development or follow up visit. All interviews were audio-recorded and transcribed for analysis. There were four themes that were explored through the interview: Professional development, teaching mathematics, teacher confidence, and perception of student learning.

Data analysis: The systematic approach of the constant comparative method was used to analyse the interview data. This form of analysis focuses on generating theory, thus a grounded methodological approach was used to analyse the data. To manage these documents a coding system was utilised to determine how to examine, cluster, and integrate themes (Creswell, 2008). The coding procedure was flexible and adopted three approaches; open coding, selective coding and axial coding. Open coding, is unrestricted identification that allows the researcher to examine the initial data to identify similarities and differences to establish initial categories (Creswell, 2008). From the interview data key words and phrases emerged. Axial coding involves examining the codes that have been determined and identify the connectedness between categories and the existing theories. Finally, selective coding was employed to examine the interrelationships between the codes to determine theories (Creswell, 2008).

Results

Teachers' Results

Three main themes were identified across the interviews, namely teachers' gains (a) from the RoleM PL, (b) in their practice, and (c) in their knowledge of mathematics. The following sections present the analysis of the data relating to each theme together with the sub-themes that emerged from the interviews. The data are presented in the order in which the themes emerged. Teacher's interview data was also coded according to whether it was their first or second year in RPL. In the second row of the table, the first, second and third interviews are represented as 1, 2, 3. The column graphs represent the frequency of teachers who referred to that particular sub-theme in their interview. Each square corresponds to one teacher agreeing with this sub-theme. Thus, a column 4 units high shows that four teachers mentioned this sub-theme in this particular interview.

Theme 1 – Teachers' Gains from the Professional Development and Follow up Visits

Six key sub-themes were identified by teachers with regard to what they gained from their participation in the professional development days. Table 2 summarises these themes, together with representative quotes for each. The themes are presented in the order of most agreement to least agreement.

Sub-theme	2010			2011			2012		
	1	2	3	1	2	3	1	2	3
Increased understanding of how to teach mathematics *Through watching and participating in the demonstrations at the PD, I didn't realise the different ways that I could teach mathematics with a hands-on approach.*		░░░░	░░░░	░░	░███	░░░	░		
Demonstrations by experts and resource provided *I love the RoleM resources and it was very helpful seeing the experts use them. It was so nice to have resources ready for us to use in our classrooms.*	░░░░░			░░	░		███		
Enhanced own learning of mathematics *I thought I knew about place value until I did the PD and found there was more to be learnt. It has enhanced my own understanding of mathematics.*					█	░█	█	░░	░
Increased understanding of how students learn mathematics *I never realised some of misconceptions that students can have and seeing how to address some of them now has helped immensely.*				██			░		░
Increased confidence to teach mathematics - *Being a new teacher, my confidence in teaching mathematics was low but since doing the PD, I am now much more confident.*		░	░			█			
Sharing with colleagues beyond the PD *I have brought RoleM back to our school and have been sharing the resources and the information gained with other teachers.*									█

Note: ░ represents teachers participating in their first year of PL
█ represents teachers participating in their second year of PL

Table 2: Frequency of teacher agreement with the sub-themes for Gains from PD and FV

There are clear shifts in the themes in the table, with the 2010 participants primarily focusing on the first two subthemes, and the other two years including examples of how RoleM PD and follow up visits (FV) had enhanced their own learning of mathematics, and increased their understanding of how students learn mathematics. The shifts are easier to see when we compare the sub-themes that emerged for each interview across the years. In summary these were:

In interview 1 theme movements were:
2010 demonstrations and resources
2011 demonstrations and resources, **how to teach mathematics, how students learn mathematics**
2012 demonstrations and resources, how to teach mathematics, how students learn mathematics, **mathematical concepts**

In interview 2 theme movements were:
2010 how to teach mathematics, confidence in teaching mathematics
2011 how to teach mathematics, confidence in teaching mathematics, **mathematical concepts**
2012 mathematical concepts

In interview 3 theme movements were:
2010 how to teach mathematics, confidence in teaching mathematics
2011 how to teach mathematics, confidence in teaching mathematics, **mathematical concept**
2012 mathematics concepts, **how students learn mathematics, sharing with others**
Note: The bolded components indicate the introduction of a new sub-theme

As the RoleM Professional learning progressed across the three years at Dragon school, the gains teachers made from the PD sessions and FV widened and deepened. For example, examining the first interview for each year: in 2010 teacher gains were purely in the areas of the mechanical aspects of the PD, the resources and demonstration of the activities; in 2011 their gains included understandings of classroom practice (an increased awareness of how to teach mathematics, and support student learning); and, in 2012 their gains included an increased understanding of mathematical concepts. Thus they moved from mechanical aspects, to pedagogical aspects to finally purported changes in their content knowledge. We conjecture that their starting point for their engagement in RoleM Professional Learning progressively moved over the three years, and this movement reflected their increased ‘buy into’, their perceived effectiveness of the program. This shift occurred across the three interviews for the three years. In fact it was not until Interview 3 of 2012 teachers shared that they had gained an increased understanding of how students learn (4 out of 5) and a willingness to share what they themselves had learned with their peers who were not involved in RoleM (1 out of 5). This teacher was one that had participated in RPL for two consecutive years.

Theme 2 – Teachers’ Gains in their Practice of Teaching Mathematics

During each year of RoleM Professional learning how these teachers taught mathematics also changed. Table 5 presents the 6 sub-themes relating to this theme together with representative quotes and the frequency of agreement with each sub-theme.

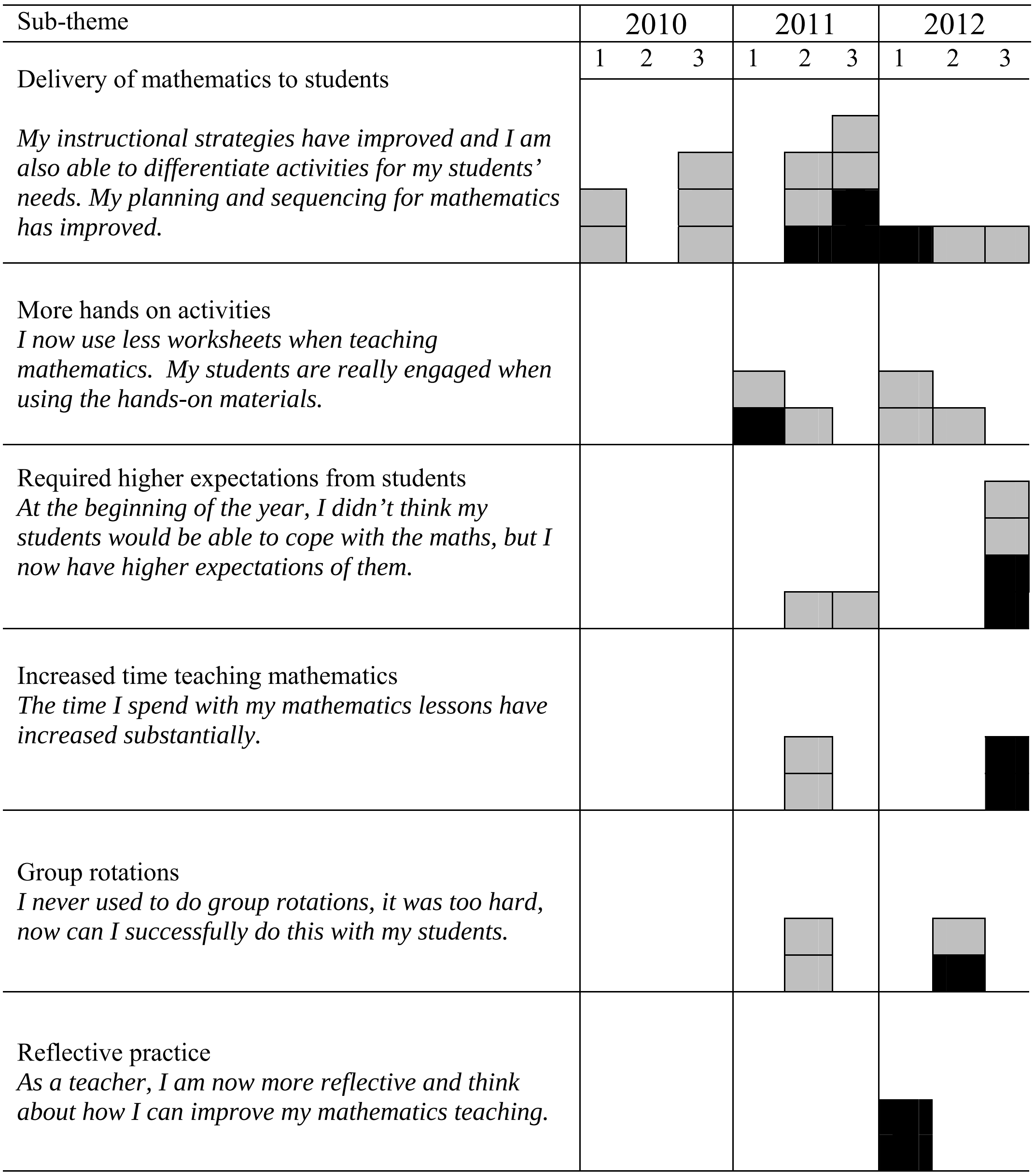

Table 3: *Frequency of teacher agreement with the sub-themes for their practice of teaching mathematics*

Note: ▭ represents teachers participating in their first year of PL
■ represents teachers participating in their second year of PL

The most common sub-theme that emerged from the interviews was improvement in the teachers' delivery of mathematics followed by the use of more hands on activities and requiring higher expectations from their students. The next section presents the sub-themes that emerged from each interview across the three years.

In interview 1 moved from
2010 Delivery of mathematics to students
2011 **More hands on activities**
2012 Delivery of mathematics to students, more hands on activities, **reflective practice**

In interview 2 moved from
2010
2011 Delivery of mathematics to students, more hands on activities**, higher expectations from students**, **time teaching mathematics, Group rotations**

2012 Delivery of mathematics to students, more hands on activities, Group rotations.

In interview 3 moved from
2010 Delivery of mathematics to students
2011 Delivery of mathematics to students, **Required higher expectations from students (1)**
2012 Delivery of mathematics to students, required higher expectations for students, **time teaching mathematics**.

In 2010, teachers had little to say about how their practice changed across the whole year. They certainly were not referring to students' learning in their interviews. Participating teachers from 2011 and 2012 were much more explicit with regard to how their practice had changed, and towards the end of each year began to discuss how they were now setting higher expectations for their students. In 2012 the level of agreement to this theme had increased to 4 out of 5 teachers discussing how their expectations for their students had increased. Even though two teachers in their first interview mentioned reflective practice in 2011, it should be noted that these teachers had participated in RPL for two consecutive years.

Theme 3 - Teachers' Gain in their Knowledge of Mathematics

Table 4 presents the sub-themes highlighted by teachers with regards to gains they made in their understanding of mathematics, in particular the content knowledge of mathematics, in their classroom over the three years of the implementation of the RoleM Professional learning model.

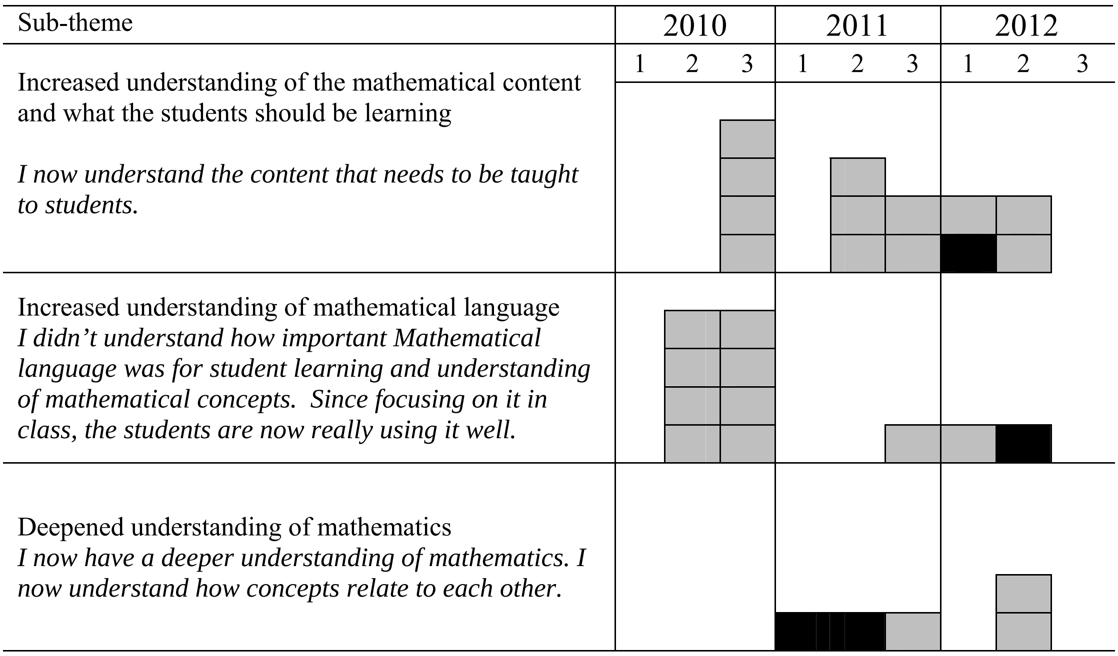

Table 4: ***Frequency of teacher agreement with the sub-themes for Knowledge of mathematics***

Note: represents teachers attending their first year of RPL
represents teachers attending their second year of RPL

The gains in knowledge were mainly in the dimensions of understanding the mathematical content and understanding mathematical language. With regard to the gains made in the knowledge of mathematics, the data exhibited similar trends as delineated to the gains they made from PD and FV, that is, teachers' knowledge gains widened and deepened across the three years. Their starting points became more complex each year, and this complexity was sustained throughout each year. The next section presents the subthemes that emerged from each interview across the three years.

In interview 1 moved from
2010
2011 **Deepened understanding**
2012 **Mathematical language, Mathematical content knowledge**

In interview 2 moved from
2010 Mathematical language
2011 **Deepened understanding**, **mathematical content knowledge**,
2012 Deepened understanding, mathematical language, mathematical content knowledge

In interview 3 moved from
2010 mathematical language, mathematical content knowledge
2011 mathematical language, mathematical content knowledge
2012

The 2010 cohort did not appear to engage with the mathematical content until the second interview, and then they progressed from mathematical language (Interview 2) to mathematical content knowledge (Interview 3). By contrast, the 2012 cohort began the year with a focus on mathematical language and mathematical content knowledge, and sustained this throughout the year.

Trends across the three tables show an overall movement from a focus on theme 1, to theme 2 to theme 3 over the three years of the RPL. In 2010 the percentage of teachers who identified various sub-themes in their interviews were: Theme 1 (46%), Theme 2 (15%) and Theme 3 (38%) with two thirds of comments for Theme 3 being in the area of mathematical language and none pertaining to deepened understanding of mathematics. In 2013 the percentage of teachers who identified various sub-themes in their interviews were: Theme 1 (29%), Theme 2 (47%) and Theme 3 (23%) with the comments for Theme 3 being spread over the three sub-themes (Deepened understanding, mathematical content knowledge and mathematical language). They had moved from talking about the PD days and follow up visits and what they gained from these, to focusing more on their own classroom practice and sharing their gains in their own knowledge about mathematics.

Students' Results

During each year of the project, all participating teachers' students sat a pre and post-test developed by the RoleM team. In 2012 the Australian Council of Education Research (ACER) were contracted to align the RoleM tests with the ACER Progressive Achievement Tests in Mathematics Third Edition (PATMaths Third Edition), a normed test developed by ACER. All students' RoleM scores were converted to PATMaths scores, which allowed for a comparison between these students' scores and the purported distribution of students' scores across Australia. Table 5 presents the number of students who completed the RoleM pre and post- tests, broken down by year level and test year.

	Test Year		
Year level	2010	2011	2012
Foundation	47		
Year 1	-	61	
Year 2	-	-	46

Table 5: Number of students who sat the RoleM pre and post-tests broken down by year level and test year

Figure 1 (below) depicts each year levels spread of scores for the pre and post-testing on the RoleM tests broken down by test year. The RoleM test scores have been converted to the corresponding PATMaths test scores. The normed distribution of PATMaths scores for Year 1 and Year 2 students are presented as the bar to the right of the figures in red. The numbers that sit next to each bar indicate the associated percentile (e.g., 50 indicates that 50% of student nationally are expected to achieve above this score).

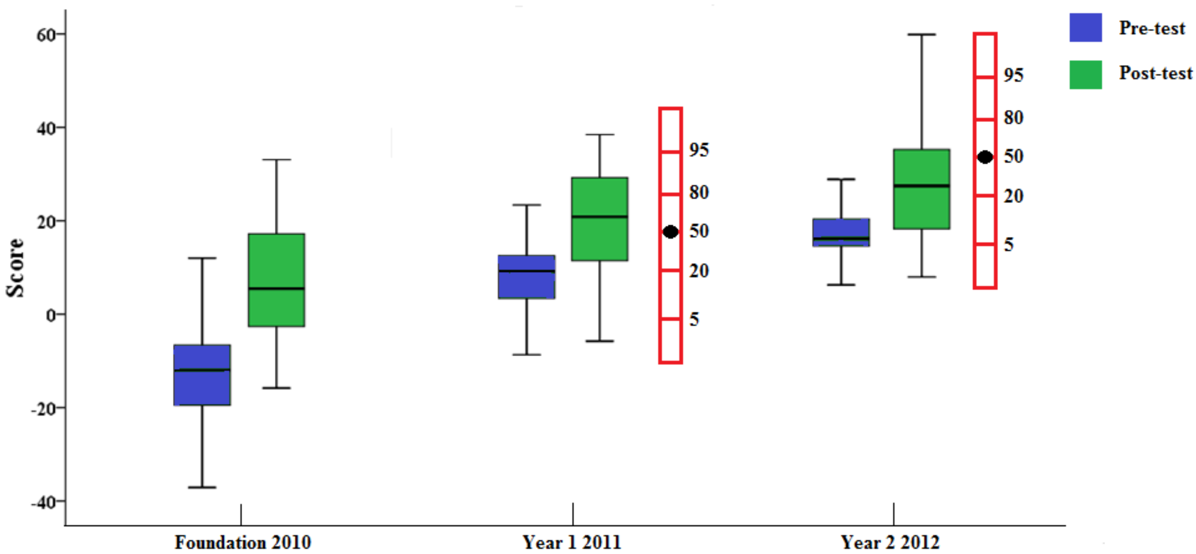

Figure 1. Pre and post-test scores of Foundation (2010), Year 1 (2011), and Year 2 (2012) students.

As Figure 1 indicates, all cohorts of students made statistically significant gains in their understanding of mathematics. In addition, the post test Box and Whisker plots indicate that by the end of each year; (a) 50% of Foundation cohort were already on the Year 1 PATMaths scale, (b) the Year 1 cohort were above the national distribution for Year 1 students, and (c) the Year 2 cohort were on the Year 2 PATMaths scale, but their mean was below the mean experienced nationally (30 as compared with 50). In order to ascertain the significance of these gains, paired *t* tests were calculated for the results of the pre and post-tests for each levels. For each *t* test the effect size was calculated. This is represented in the table as eta-squared (the percentage of variance explained by the intervention). Cohen (1988, p. 283) proposed the following values in analysing the effect of an intervention: .01 (Small effect); .06 (Medium effect) and > .138 (Large effect). Table 6 presents the results of this analysis.

Cohort	Year	*N*	Pre-test	Post-test	Average improvement	*t*	eta²	*p*
Foundation	2010	47	12.74(13.26)	7.20(13.85)	19.94	10.7	0.71	<.001*
Year 1	2011	61	8.44(7.22)	21.47(12.50)	13.03	10.72	0.66	<.001*
Year 2	2012	46	17.05(6.57)	28.58(11.32)	11.53	7.27	0.54	<.001*

Note: * indicates that the difference between the pre and post-test means scores was statistically significant.

Table 6:PAT Math scores of Prep, Year 1, and Year 2 students who sat the pre and post RoleM tests

The eta-squared values indicate that the effect size of the RoleM intervention for each student cohort was large.

Discussion and Conclusion

Effects of Professional Learning

The effects of RoleM professional learning model are efficacious for supporting teachers' professional learning. It also results in significantly improved learning outcomes for their students. Teachers identified that there were particular factors that influenced their professional learning. Initially in the early stages of the RPL model, after teachers participated in the first PD, they identified that their gains were mainly around themes relating to the mechanical dimensions of RoleM. Teachers' gains were predominately about the resources provided by the project and observed demonstrations from experts. While quality resources and demonstrations are an important component of professional learning, these alone will not improve students' learning outcomes nor result in quality teaching, that is teachers who augment students' affective and academic domains (Hattie, 2003) and exhibit 'ambitious teaching' (Lampert et al, 2010). Often mechanical gains are the types of gains that occur when teachers attend one off professional development days (Boyle, Lamprianou, & Bolye, 2005). Conversely, participating in year-long professional development gives teachers the opportunity to develop a better understanding in terms of their own pedagogical knowledge and content knowledge of mathematics. The results of RPL showed that once teachers developed a deeper understanding of mathematics and the ways of teaching mathematics impacted on their expectations for their students' learning. Understanding where all students are 'at' in their learning is a key dimension of highly effective instructional programs (Kent, 2004). Therefore, it is the intertwined relationship of quality resources and quality professional learning that results in quality improvements in the learning outcomes for students from disadvantaged contexts. But this learning is not instantaneous and requires ongoing long-term support from experts in the field.

Stages in Supporting Teacher Change During Professional Learning

While participating in the RPL model, we conjecture that teachers transitioned through five stages of professional learning as they moved towards becoming expert teachers, with each involving different support. As teachers moved through the stages, they deepen their understanding, change their practice, and finally recognise how these changes impact on students' learning. The initial stage focuses on *gaining teachers' interest* in the RoleM professional learning model. This was achieved by the provision of quality resources, quality activities that teachers could immediately use in their classrooms, in conjunction with experts demonstrating how to implement these activities using hands-on resources. These aspects are particularly crucial for gaining the interest of teachers working in disadvantaged contexts, contexts where there is high staff turnover and minimal expertise to call on for help (Lyons et al., 2006).

The second stage involves *heightening teachers' engagement*, an important stage for teachers to experience. This stage commenced with teachers independently trialling the activities and resources in their classroom environment. As they trialled the activities they observed their students increasing engagement in the mathematics, with a resultant shift in how these teachers delivered mathematics to their students. Thus, the third stage is *changes in teachers' pedagogical knowledge*. Experts modelling the activities in their classroom had a substantial impact on this dimension. This gave teachers the opportunity to draw on the experts' experiences and re-engage with the resources/activities that they were experiencing difficulty with in their classroom context. As Dewey stated, genuine thinking only occurs "when there is a tendency to doubt" (as cited in Garrison, 2006, p. 3). With ongoing support, teachers and 'experts' become co-constructors of knowledge moving within and beyond each others' ZPD. During this stage there was a marked shift away from using worksheets in mathematics to providing more engaging activities, and differentiating the activities to cater for the diverse range of students. Catering for the diversity that commonly exists in these contexts resulted in teachers beginning to observe *all* their students' learning. For many this was a revelation as often teachers working in these contexts hold a belief that these students are not capable of achieving (Hewiston, 2007).

Stage four links to *changes in teachers' content knowledge*. As teachers gained a deeper understanding of the mathematics they applied this to both the high achieving students and students at risk in their everyday teaching. Teachers were able to easily adapt learning activities to cater for students on an individual basis during lessons, and began to exhibit the traits of expert teachers; teachers who have knowledge that is more integrated and are flexible in its use in the classroom (Borko & Livingston, 1989). During this stage teachers also shared their experiences, both successes and failures, with others. Importantly, this stage resulted in a more reflective practitioner.

The final stage is teachers *holding higher expectations for students*. At this stage teachers had begun to identify that they have an influence over their students' learning. During this stage, the influences that often are equated with students not achieving (e.g., external school factors, absenteeism, behaviour, language) were no longer an excuse for students not making gains. Expert teachers also take ownership of their lessons, changing and adding to them as needs may emerge and goals change (Borko & Livingston, 1989). Expert teachers set high expectations for students from disadvantaged contexts and know what to teach, and how to structure and organise this in the context of their particular students and circumstances (Askew, 2008). Figure 2 displays a proposed professional learning trajectory with the stages teachers/ progress through which, as they become experts in teaching mathematics in disadvantaged contexts.

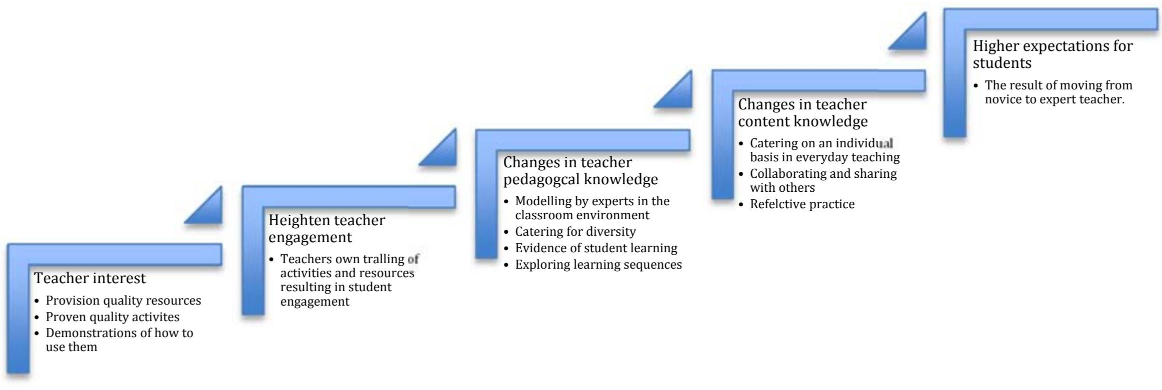

Figure 2. Professional learning trajectory for the formation of expert teachers teaching mathematics in disadvantaged contexts.

This trajectory aligns with the stages identified in our previous research with regard to supporting teachers to become effective teachers in disadvantaged contexts (Warren & Quine, 2013), namely, first building teachers' confidence (teacher interest and heightened teacher engagement), second building students' confidence (changes in teachers' pedagogical knowledge), and finally increasing expectations for students (changes in teachers' content knowledge and higher expectations for students). They also align with Desimone's (2009) suggested steps of effective professional development. Namely, these are, teachers' experiencing effective PD, PD increases teachers' knowledge and skills, teachers use this to improve their instruction, and instructional changes foster increased student learning.

The Benefits of Three Years' Focus on Professional Learning in Mathematics

There are major benefits to providing support for teachers' professional learning in one particular subject area over a three year period, especially if it is planned and focused. This is best evidenced by the conjectured trajectory as delineated in Figure 2. In the initial year of professional learning (2010) teachers engaged with RLP, began to realise the connectedness of their own understandings of mathematics and effective pedagogy, and finally to appreciate the positive effect these changes had on their students' learning. But more importantly, in the second year (2011), the starting point for new participating teachers' on the professional learning trajectory was further advanced. There are two proposed reasons for this. First, their students had already experienced RoleM in the previous year. Thus, as these students entered their classrooms they were already engaged with learning mathematics and had experienced success, something quite rare in these contexts. Second, they had learnt from their peers that RoleM was a worthwhile 'buy in'. They already believed that the program is worthwhile. It is in the third year, that these changes and positive outcomes are entrenched. Thus, while one years focus on teachers' professional learning of mathematics begins to shift in teachers' mathematical teaching, the shift is greater (and more sustainable) in the next two years of participation (as evidenced by the shift in teachers focus in 2012 and 2013). Fundamental to these gains is the provision of quality resources and quality conversations with experts in the field.

Implications for the Professional Learning of Teachers Working in Disadvantaged Contexts

The results from this research have implications for professional learning for teachers teaching mathematics in disadvantaged contexts. If the effective teachers' primary focus is on student learning in terms of their affective domain and academic achievement (Hattie, 2003), the professional learning needs to occur in these contexts over an extended period, as it was only in the second year of participation that student learning became a primary focus for these teachers. In addition, it was only after a three-year period that teachers saw themselves as capable of structuring and organising the learning to cater for their particular students and circumstances, the hallmarks of effective teachers (Hattie, 2003). From this, the five principles underpinning the RoleM professional learning model (teacher knowledge to improve students' learning; PD situated in the context; providing multiple opportunities to change teacher beliefs and attitudes; resourcing for effective teaching) translates to building teacher confidence, building student confidence and increasing expectations for students' learning. We also hypothesise that in these contexts where teachers are consistently moving in and out, an approach of focusing on a new subject area in each progressive year is ineffective. It results in a constant process of 'reinventing' the wheel and constantly starting at the beginning of the professional learning trajectory. We conjecture a more effective approach is an ongoing focus on the key subjects areas of literacy and mathematics, the two areas that are known to lead to future employment and future educational opportunities (Lamb & McKenzie, 2001; Zappala, 2003). In addition to a PD program with a trajectory aiming at building teacher expertise and heightened student expectations, the researchers believe this is a platform that warrants further exploration in application to other subject domains and socio-economic contexts.

References

Askew, M. (2008). Mathematical discipline knowledge requirements for prospective primary teachers, and the structure and teaching approaches of programs designed to develop that knowledge. In K. Krainer & T. Wood (Eds.), *The International Handbook of Mathematics Teacher Education* (Vol. 1, pp. 13-36). Rotterdam, The Netherlands: Sense Publishers.

Aubrey, C., Dahl, S., & Godfrey, R. (2006). Early mathematics development and later achievement: Further evidence. *Mathematics Education Research Journal*, 18(1), 27-46.

Australian Council of Assessment and Reporting Authority (ACARA). (2013). *My school*. Retrieved from http://www.myschool.edu.au

Australian Council of Assessment and Reporting Authority (ACARA). (2009). *Annual report 2008 -2009.* Retrieved from http://www.myschool.edu.au

Boaler, J., & Staples, M. (2008). Creating mathematical futures through an equitable teaching approach: The case of railside cchool. *Teachers' College Record,* 110 (3), 608-645.

Borko, H., & Livingston, C. (1989). Cognition and improvisation: Differences in mathematics instruction by expert and novice teachers. *American Educational Research Journal*, *26*(4), 473–498. doi:10.3102/00028312026004473

Borman, G. D., & Kimball, S. M. (2013). Teacher quality and educational equality : Do teachers with higher standards- ratings close student achievement gaps ? *The Elementary School Journal*, 106(1), 3–20.

Boyle, B., Lamprianou, I., & Boyle, T. (2005). A longitudinal study of teacher change: What makes professional development effective? Report of the second year of the study. *School Effectiveness and School Improvement*, 16(1), 1–27.

Brockbank, A., & McGill, I. (2006). *Facilitating reflective learning through mentoring and coaching*. Philadelphia: Kogan Page.

Castle, K., & Aichele, D. B. (1994). Professional development and teacher autonomy. In D. B. Aichele & A.F. Coxford (Eds.), *Professional development for teachers of mathematics.* 1994 Yearbook. Reston Virginia: National Council of Teachers of Mathematics.

Clements, D. H. (2004). Major themes and recommendations. In D. H. Clements & J. Sarama (Eds.), *Engaging Young Children in Mathematics: Standards for Early Childhood Mathematics Education* (pp. 7-72). Matwah, NJ: Lawrence Erlbaum Associates

Cobb, P., & Jackson, K. (2011). Towards an empirically grounded theory of action for improving the quality of mathematics teaching at scale. *Mathematics Teacher Education and Development*, *13*, 6–33.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Earlbaum Associates.

Creswell, J. (2008). *Research design: Qualitative, quantitative, and mixed methods approaches* (3rd ed.). Thousand Oaks, CA: Sage.

Darling-Hammond, L. (1997). *The right to learn*. San Francisco: Jossey-Bass.

Edwards, B. (2005). Does it take a village? An investigation of neighbourhood effects on Australian children's development. *Family Matters*, 72, 36-43.

Frigo, T., & Simpson, L. (2001). *Research into the numeracy development of Aboriginal students: Implications for NSW K-10 mathematics syllabus.* Melbourne: Australian Council for Educational Research.

Garrison, J. (2006). The "permanent deposit" of Hegelian thought in Dewey's theory of inquiry. *Educational Theory, 56*(1), 1–37.

Gervasoni, A., Parish, L., Upton, C., Hadden, T., Turkenburg, K., Bevan, K., et al. (2010). Bridging the numeracy gap for students in low SES communities: The power of a whole school approach. In L Sparrow, B. Kissane, & C. Hurst (Eds.), *Shaping the future of mathematics education, Proceedings of the 33rd annual conference of the Mathematics Education Research Group of Australasia*, pp. 202-209, Fremantle: MERGA.

Gonski, D., Boston, K., Greiner, K., Lawrence, C., Scales, B., & Tannock, P. (2011). *Review of funding for schooling—final report*. Canberra, Australia: Department of Education, Employment and Workplace Relations.

Gravani, M. (2007). Unveiling professional learning: Shifting from the delivery of courses to an understanding of the processes. *Teaching & Teacher Education, 23*, 688-704.

Griffin, S., & Case, R. (1997). Re-thinking the primary school math curriculum: An approach based on cognitive science. *Issues in Education*, 3(1), 1-49.

Guskey, T. R. (2003). How classroom assessments improve learning. *Educational Leadership, 60*(5), 6-11.

Hattie, J. (2009). *Visible learning*. London: Routledge.

Hattie, J.A. (2003, October). Teachers make a difference: What is the research evidence? Background paper to invited address presented at the 2003 *ACER Research Conference*, Carlton Crest Hotel, Melbourne, Australia. Retrieved from http://www.acer.edu.au/documents/TeachersMakeaDifferenceHattie.doc

Hargreaves, A. (2003). *Teaching in the knowledge society: Education in the age of insecurity*. New York: Teachers College Press.

Heslop, J. (2011). Living and teaching in Aboriginal communities. In Q. Beresford & G. Partington (Eds.), *Reform and resistance in Aboriginal education* (pp. 208-238). Perth: University of Western Australia Press.

Hewitson, R. (2007). Climbing the educational mountain: A metaphor for real culture change for Indigenous students in remote schools. *The Australian Journal of Indigenous Education*, 37, 6-20.

Jackson, K., & Cobb, P. (2010). *Refining a vision of ambitious mathematics instruction to address issues of equity*. Retrieved from http://peabody.vanderbilt.edu/docs/pdf/tl/MIST_refining_vision_100702

Jarvis, P., & Parker, S. (Eds.). (2005). *Human learning: A holistic approach*. New York: Routledge.

Jones, M. (2009). Transformational learners: Transformational teaching. *Australian Journal of Teacher Education*, 34(2), 14-27.

Kent, A. M. (2004). Improving teacher quality through professional development. *Education*, 124(3), 427–435.

Lamb, S., & McKenzie, P. (2001). *Patterns of success and failure in the transition from school to work in Australia*, LSAY Report 18, Melbourne: ACER.

Lampert, M., Beasley, H., Ghousseini, H., Kazemi, E., & Franke, M. L. (2010). Using designed instructional activities to enable novices to manage ambitious mathematics teaching. In M. K. Stein & L. Kucan (Eds.), *Instructional Explanations in the Disciplines* (pp. 129-141). New York: Springer.

Lupton, R. (2004). *Schools in disadvantaged areas: Recognising context and raising quality*. Retrieved from http://sticerd.lse.ac.uk/dps/case/cp/CASEpaper76.pdf

Lyons, T., Cooksey, R., Panizzon, D, Parnell, A., & Pegg, J. (2006). *Science, ICT and mathematics education in rural and regional Australia: The SiMERR national survey*. Canberra: Department of Education, Science and Training.

Mills, C., & Gale, T. (2003). Transient teachers: Mixed messages of schooling in regional Australia. *Journal of Research in Rural Education* 18(3), 145-151.

Ministerial Council for Education Early Childhood Development and Youth Affairs (MCEECDYA). (2011). *Aboriginal and Torres Strait Islander education action plan 2010-2014*. Canberra: Commonwealth of Australia.
Murrell, P. (2001). *The community teacher: A new framework for effective urban teaching*. New York: Teachers College Press
Phillips, P. (2008). Professional development as a critical component of continuing teacher quality. *Australian Journal of Teacher Education, 33*(1), 1-9.
Porter, A., Garet, M., Desimone, L., Birman, B., & Yoon, K. S. (2000). *Does professional development change teaching practice? Results from a three-year study*. Washington, DC: U.S. Department of Education.
Price-Robertson, R. (2011). *What is community disadvantage? Communities and families clearing house Australia*: CAFCA resource sheet. Retrieved from www.aifs.gov.au
Salpeter, J. (2003). 21st century skills: Will our students be prepared? *Technology and Learning, 24*(3), 17-26.
Schon, D. A. (1983). *The reflective practitioner: How professionals think in action.* New York: Basic Books.
Smart, D., Sanson, A., Baxter, J., Edwards, B., & Hayes, A. (2008). *Home-to-school transitions for financially disadvantaged children: Final report*. Sydney: The Smith Family.
Timperley, H. (2008). *Teacher professional learning and development*. Brussels, Belgium: International Academy of Education.
van Manen, M. (1977). Linking ways of knowing with ways of being practical. *Curriculum Inquiry, 6*(3), 205-228.
Vinson, T. (2007). *Dropping off the edge: The distribution of disadvantage in Australia. Australia*. Sydney: Catholic Social Services Australia.
Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.
Warren, E. (2009). Early childhood teachers' professional learning in early algebraic thinking a model that supports new knowledge and pedagogy. *Mathematics Teacher Education and Development*, 10, 30-45.
Warren, E. & Quine, J. (2013). Enhancing teacher professional development for early years mathematics teachers working in disadvantaged contexts. In L. English & J. Mulligan (Eds.) *Reconceptualizing Early Mathematics Learning: Advanced Series in Mathematics Education*. Berlin: Springer.
Warren, E., & DeVries, E. (2009). Young Australian Indigenous students' engagement with numeracy: Actions that assist to bridge the gap. *Australian Journal of Education*, 53(2), 159-175.
Webster-Wright, A. (2009). Reframing professional development through understanding authentic professional learning. *Review of Educational Research*, 79(2), 702-739.
Weiss, I., & Pasley, J. (2004). What is high-quality instruction? *Education Leadership*, 61 (5), 24–28.
Wells, G. (1999). *Dialogic inquiry: Toward a sociocultural practice and theory of education*. New York: Cambridge University Press.
Wenglinsky, H. (2002). How schools matter: The link between teacher classroom practices and student academic performance. *Education Policy Analysis Archives*, *10*(12), 1-30.
White S., & Reid, J. (2008). Placing teachers? Sustaining rural schooling through place consciousness in Teacher Education. *Journal of Research in Rural Education, 23* (7), 1-11.
Zappala, G. (2003). *Barriers to participation: financial, educational and technological: a report into the barriers to societal participation among low-income Australians*.

Camperdown, New South Wales: The Smith Family.

Acknowledgments

The research reported in this paper was supported by Australian Research Council under grant LP100100154. The authors express their thanks to Eva deVries, participating teachers, Indigenous education officers, students and school communities for their generous support of this project.