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**The Impact of the Mathematical Identity of  
School Leaders on Professional Development  
in Mathematics Education in NZ primary  
schools**

**A CASE STUDY OF TWO NEW ZEALAND  
PRIMARY SECTOR SCHOOLS**

A thesis presented in partial fulfilment  
of the requirements for the degree of

**Master of Education**

at Massey University, Albany, New Zealand.

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## **ABSTRACT**

This study draws on psychoanalytical theory and research data to explore the experiences and impacts of different educational leadership approaches to improving teacher practice in primary sector mathematics education. Under consideration are the behaviours exhibited by Principals in response to their personal relationship with mathematics. Specifically, it examines how the mathematical identity of a Principal may influence their educational leadership of mathematics, how that may affect the provision of professional development for teachers who teach mathematics, and how that, in turn, affects the mathematical identity of those teachers.

A review of the research literature reveals the importance of considering both the social and intrapersonal nature of mathematical identity and the interpersonal relationships of leadership and has led to this study being placed in the constructive philosophical approach from a Lacanian psychoanalytic context. The study also acknowledges the indeterminate nature of what the future holds, including the aim of school achievement, and defines this study as embedded in the postmodern system of ideas as a means of viewing social and cultural phenomena. The study is a comparison between two contrasting school environments. Consistent with an interpretive approach, data collection and analysis have complementary roles with each activity informing the other. Data collection instruments used for this study were the questionnaire, personal interviews, focus group interviews, and the researcher.

The investigation revealed that a Principal who consistently addresses their mathematical identity, through direct participation in professional development, is more likely to correctly identify strategic development needs and to provide appropriate professional development in mathematics. This provision addresses the mathematical identity of teachers by improving mathematical content and pedagogical knowledge. The study found that many Principals were educated through a behaviourist pedagogy and that participation in current professional development allowed them to better understand the constructivist approach of contemporary mathematics education and best practice in classroom practice. The Principal's personal participation also builds relational trust with the teaching team, enabling the conditions for a learning culture within their school. From these findings, recommendations are made for Principals to reflect upon the effective provision of professional development in mathematics whilst considering how psychological influences might affect their educational leadership of mathematics and teacher practice.

# **CANDIDATE'S STATEMENT**

I certify that the research project entitled:

**The Impact of the Mathematical Identity of School Leaders on  
Professional Development in Mathematics Education in NZ primary  
schools**

**A Case Study of Two New Zealand Primary Schools**

and submitted as part of the Master of Education, is the result of my own work except where otherwise acknowledged and that this research project (or any part of the same) has not been submitted for any other degree to any other university or institution.

Signed: \_\_\_\_\_

Stephen Kendall-Jones

Date: \_\_\_\_\_



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# **CHAPTER 1: INTRODUCTION**

## **1.1 Background to Research**

The interest for this research was sparked by the New Zealand Government's implementation of National Standards for the areas of reading, writing, and mathematics. During conversations with other teachers, the question of appropriate professional development in these areas was raised and whether the mathematics professional development would relate to the Numeracy Project or not. Coincidentally, the researcher was involved in the Ministry of Education's National Aspiring Principals Programme and noticed that, when discussing mathematics education, many participants expressed a lack of confidence in content and pedagogical knowledge. Further formal and informal discussions with principals reinforced my impression that school leaders were more likely to have language and literacy strengths than mathematics. As a teacher, the researcher's experience of professional development in mathematics was that far less was offered when compared to other curriculum areas, such as English language learner support and literacy. As a result, the researcher identified the need to explore the strengths of school principals in terms of mathematics and to examine whether a lack of strength, or identity, as a mathematician could lead to less or more focus on leading the learning of mathematics education in their schools. In an attempt to understand the translation of a school leader's mathematical identity into teacher practice, the gateway through which the process was examined was professional development.

This study represents a means to understand and explain the influence of educational leadership on improving teacher practice in mathematics education. It approaches the topic from consideration of the variables and uncertain practices that make up the teaching and learning of mathematics. Walshaw says that mathematics teaching is a construct that is, "situated within institutions, historical moments, as well as social, cultural, and

discursive spaces.” (Walshaw, 2010b, p.xi). In bringing together the leader’s identity as a mathematician and the influence this may have on the teacher’s practice as a result of professional development, this study fills a gap in research by approaching a dimension of leadership of mathematics practice in a previously unconsidered way.

Literature on the topics of ideological constructs of leadership, mathematical pedagogy, classroom practice, and the relationships between the three, lead to prescriptive conclusions that most participants are persuaded they should follow without recourse to consideration of personality, disposition, culture, and identity. This research is an attempt to integrate the lens of identity when viewing such important constructs.

Mathematics pedagogy is the main key for the formation of student mathematical identity and proficiency. Such developed proficiency is a social measure of future opportunity for an individual, which signifies “upward mobility and meritocracy for the successful individual student” (Walshaw, 2010b, p.xii). In contrast, a lack of mathematics achievement for many students has led to calls for changes in formalized mathematical pedagogy from governmental departments who insist on a program of high levels of scrutiny and audit to identify achievement measures against a distribution curve. Once again, Walshaw summarizes the phenomenon well; “a picture emerges of pedagogical competency as servicing the political economy of the nation state... through which complex and ongoing social issues are invested and filtered.” (p. xiii). Each and every influence shapes the identity of the educational leader and the teacher of mathematics and we, as researchers, need to appreciate the variety of influences present within socio-economic, legal-political, cultural and historical sub-contexts when we examine pedagogical practice.

Consideration of the external and intrapersonal nature of mathematical identity has led to this study being placed in the constructive philosophical approach from a psychoanalytic context. The psychoanalytic theory used in

this research, when considering principal and teacher development, is from the work of French psychoanalyst Jacques Marie Emile Lacan (1901 to 1981). Lacanian theory proposes a triangle of relationships between our pre-language selves, labeled 'Real' selves; the self that is constructed in response to our relations with other people, labeled the 'Imaginary' self, and; one's relationship with the rules and structures of the society in which we live, which he terms the 'Symbolic Other'. From a Lacanian perspective, we are constantly trying to make meaning from the conflict within the essence of ourselves, ourselves as defined through other people, and ourselves in relation to authority, rules and regulations. The dissonance between the three selves arises because language structures our relationships with others, separating our 'real' selves from others. Language allows us to mirror ourselves, creating the 'imagined' self. Language also structures people in relation to society, such as the institutional practices considered within this research. This is the 'symbolic other' that represents institutional authority. "In the Lacanian sense, meaning is not fixed, but is exploratory, and it provides a creative sense for us as we develop a sense throughout our life of one meaning leading onto another" (Black, Mendick, & Solomon, 2009, p. 55). In this research, mathematics, as a subject, is also considered to be a rule bound symbolic other, whilst the Principals and teachers are attempting to find meaning in the context of mathematical pedagogy.

This study approaches educational leadership from the understanding that the role of Principal is complex and often conflicting in terms of resources and priorities. School leadership is established in specific and unique contexts. The study also acknowledges the indeterminate nature of what the future holds and, consequently, the indeterminate nature of the aspirations of school achievement. This complex and uncertain future defines the approach of this study as firmly embedded in the postmodern system of ideas as a means of viewing social and cultural phenomena.



## 1.2 Definition of Terms

Some terms in education and educational research are expressed with the assumption that all users in their contexts understand those terms in a similar way. However, in research, it is important that terms are clearly defined to eliminate any misunderstanding the reader may have based on a differing definition. One example would be the use of the term ‘professional development’, which, in New Zealand’s Best Evidence Synthesis on teacher professional learning and development, is defined as “the dissemination of information to teachers in order to influence practice. Ideally this involves professional learning”. Professional learning is defined as “a broad term to describe an internal process by which individuals create professional knowledge” (Timperley, Wilson, Barrer, & Fung, 2007, p. 284). However, this definition is constrained by the focus on teachers that reflects the purpose of that particular synthesis. For the purpose of this research the following definition for professional development as provided by the National Staff Development Council is used: *“Professional development is a comprehensive, substantiated, and intensive approach to improving teachers’ and principals’ effectiveness in raising student achievement”* (National Staff Development Council, 2008, p. 6).

‘Identity’ is a term that requires clarification. Wenger’s (1998) concept of identity focuses on membership of social communities of practice. He describes it in terms of a medium for understanding: “the concept of identity serves as a pivot between the social and the individual, so that each can be talked about in terms of the other... The resulting perspective is neither individualistic nor abstractly institutional or societal” (p. 145). For the purposes of this research, a wider view is taken utilising a distinction between grounded positional identity and a figured, or imagined, identity (Holland, Lachicotte, Skinner, & Cain, 1998). Whereas *positional* identity, such as described by Wenger, is based on specific communities and describes how people understand and “enact their positions in the worlds in

which they live” (Boaler & Greeno, 2000, p. 173), *figured* identity encompasses the ways in which individuals act with personal identity constructs. Holland and colleagues conceive of individuals not only making sense of new situations but also constructing new meaning during the process. However, when improvising and conceiving of new practices and ideas, individuals do so in response to barriers inherent in both positioned and figured identities. These influences create new ways of behaving and ‘being’, constrained by existing grounded and imagined identities. In applying the term ‘identity’ to a person’s relationship to mathematics as a learning context, i.e., mathematical identity, it is noted that the nature of mathematics is contested (Davis & Hersh, 1998) and that school mathematics is often quite different from the nature of mathematics undertaken by mathematicians (Burton, 2001, 2002). In the context of this research, unless otherwise stated, the term ‘mathematics’ refers to mathematical practices as taught and learnt in primary sector school settings and primary sector mathematics education programs. The level of mathematical identity is described in terms of strong and weak. ‘Strong’ refers to a positive relationship with mathematics as an area of learning. ‘Weak’ refers to little or no positivity towards mathematics. Anxiety towards mathematics indicates a negative relationship towards mathematics or a component of mathematics.

### **1.3 Research Focus**

This research aims to provide an in-depth examination of the impact of the contrasting development of the mathematical identities of two principals, on their application of educational leadership of mathematics education for their teaching teams through the provision of professional development. It focuses on a set of broad questions that serve as the map for the inquiry:

1. When using a distributed leadership approach, how does a school leader ensure implementation of best practice in mathematical pedagogy?
2. How does a principal's mathematical identity influence their leadership of the mathematics curriculum area?
3. What factors influence a principal's identification of professional development needs with regards to mathematics education?
4. How is school-wide professional growth in mathematics pedagogy influenced by the Principal's participation in professional development activities?
5. In what ways might the various mathematics professional development activities, participated in by the schools in this study, affect the mathematical identities of the teachers at those schools?

#### **1.4 Thesis outline**

This thesis, presented in six chapters, provides an explanation of how the research was conducted and how findings emerged from data traceable to the research questions. Chapter One justifies the need for this research and the theoretical basis for the approach taken.

Chapter Two presents a literature review in three sections. The first contains a discussion of contemporary school leadership. The tensions and challenges faced by school leaders in modern educational systems are illuminated and some clarity is sought around the effective use of distributed leadership in the context of professional development. The second section explores mathematical identity and related mathematical anxiety. The third section considers the literature on professional development, the effectiveness of various types of professional development, and effective mathematical professional development in particular.

The methodology used in this research is considered in Chapter Three. This includes discussion of the case study approach and grounded theory methods in the analysis. Issues of validity, reliability and the dilemma of generalisation are included. A description of the method selection relating to two case study schools examined in this study and ethical issues specific to this research are outlined. Data collection tools and methods for recording data are discussed.

Given the contrasting nature and complexity of the data, the researcher decided to present the findings for the two schools under focus in separate chapters. Chapters Four and Five present the findings from the data for each school separately. For ease of perspective, quotes from the Principal are shown in blue italics and quotes from teachers in purple italics.

Chapter Six discusses the findings from the data: The correlation between a principal's mathematical identity and educational leadership in mathematics; the selection process used to identify professional development activities best suited to the needs of teachers; the promotion of, and participation in, professional development, and; the effect this has on the teaching team's mathematical identity are explored. The final part of this chapter addresses the research questions and discusses the strengths and limitations of the research approach and methodology. It suggests implications based on the findings. The chapter concludes with suggestions for future research.

In order to ensure confidentiality, great effort has been made to ensure that the schools and personnel cannot be identified. This has resulted in gender references being eliminated as far as possible. Instead of the pronouns and use of third person singular, i.e., he or she, it has been necessary to refer to people as 'she or he' (or vice-versa) or to use the grammatically incorrect third person plural, i.e., them or equivalent. Such methods may reduce the reader's flow and I beg your understanding.

## **CHAPTER 2: LITERATURE REVIEW**

### **2.1 Introduction to literature review**

The teacher is widely accepted to be central to all students' school education. There are many research studies available that document both successful and unsuccessful teaching practice in mathematics. Rarely have studies linked the mathematical identity of the school leader and their provision of professional development in mathematics.

Relevant literature falls into several categories. Firstly, this literature review will examine research related to the educational leadership of schools by the Principal. Secondly, it will review the body of research on mathematical identity, including maths anxiety, and how educators understand themselves as mathematicians. Finally, it shall relate school leadership to how the leader understands the improvement needs of staff and subsequently provides professional development, specifically in mathematics. Various types of professional development and their effectiveness are explored in the final section.

### **2.2 The role of the school leader**

This section attempts to set the context of contemporary school leadership from a range of viewpoints in order to establish the complexity of the role, the operational environment, and the leader's impact on classroom practice as educational leaders. The question approached in this study is how principals can best lead the specialised field of mathematics education with its distinct pedagogy.

In the past 20 years, the model of school leadership has changed dramatically. Schools have been changed in terms of governance and management (e.g., New Zealand's Tomorrow's Schools policies) and subsequent changes in leadership have been necessary. Some leadership

models highlight the necessity for the leader to “establish a clear and consistent vision” (Sammons, Thomas, & Mortimore, 1997, p. 199), whilst others consider leadership as managerial (Slee, Weiner, & Tomlinson, 1998) or transformational (Fullan, 1992). Sergiovanni (2009) emphasises the moral, purpose driven aspects of leadership, through his metaphor of one’s heart, head and hand.

Just as there are many models, there are equally as many researchers who critique these models, claiming that many of the models fail to take into account the contexts in which the model will act. Leithwood (2001) says that the models fail to cover the full gamut of leaders’ responsibilities and that a deeper exploration of leadership in context is required. Leithwood also states that governmental expectations of accountability has led to market approaches in schools, where ‘customer’ relationships and ‘customer’ satisfaction has become part of school operations.

The move from centralised control towards more decentralised accountability of schools requires school leaders to empower others whilst staying in touch with ‘best’ practices and assisting staff in working towards improvement in professional practice. Principals are expected to lead through vision statements, goal setting against strategic plans, facilitating professional learning conditions, monitoring and appraising staff against professional standards, curriculum leadership and implementation, and keeping strong communication links with the wider community of stakeholders including parents and whanau (a Maori word meaning the extended family, which can include up to three or four generations). They are also expected to manage the physical demands of the school.

### ***2.2.1 School leadership and management***

The administrative function of principals has grown over the past two decades and the connection with teachers may have suffered as a result of school leaders focusing more on management issues (Fink & Resnick,

2001). Administration duties, including, “planning, decision-making, coordination, guidance, development of institutional culture, and communication between individual groups” are necessary to achieve school objectives (Dalin & Kitson, 2004, p. 71). This is a major issue, which has been described as being “the ‘urgent’ agenda imposed on heads and increasing accountability demands for managerial responses” (Davies, 2002, p. 196).

The common ground for all Principals, regardless of context, should be to encourage learning. The requirement for system management leaves less time to be directed towards student achievement and recognition of this tension has led to a call for school leaders to be more focused as educational leaders, “ensuring that students are learning in the best possible manner” (Ontario Principals’ Council, 2009, p. 1). Although day-to-day management is vital to any school, managerial activities should be seen within the context of encouraging learning rather than as ends in themselves. A principal should consider teaching, reflect about pedagogy and classroom practice, and champion the vision of how teaching and learning can be effectively developed (Stewart, Duncan, & Prebble, 1997).

### ***2.2.2 Post-transformational leadership***

Contemporary research examines leadership in terms of people and relationships rather than tasks (Fullan, 2002). Writers use the term ‘transformational leadership’ to describe the kind of leadership required to bring about a cultural shift in a school. Transformational leadership has been criticised for not accepting the synergies of collective activity, distributed leadership and the requirements of stakeholder buy-in. Sergiovanni (2009), Fullan (2002, 1992) and Leithwood and Jantzi (1999), amongst others, have expanded the original transformational model into what is now known as post-transformational leadership. Post-transformational leadership allows for a distributed leadership model whereby the values and purpose of the school underpin any actions, individuals are encouraged to use their

initiative and innate leadership ability to build capacity in the school's personnel.

Leaders acting within the post transformational leadership model encourage openness and the building of relational trust. Building relational trust is one of four leadership knowledge, skills and dispositions, or KSDs (Robinson, Hohepa, & Lloyd, 2009) that leaders need to engage with the leadership dimensions identified by the New Zealand iterative Best Evidence Synthesis on School Leadership and Student Outcomes (p. 46). This trust is directed towards gaining consensus around directions that the team can believe in. West, Jackson, Harris and Hopkins (2000) proffer that, when relational trust progresses towards a consensus that student achievement is the prime 'core business' of a school, school staff will recognise the need to improve their practices towards this need. This is more pronounced when faced with student achievement data and assessment literacy professional development. As a result, the school will become a learning system with a learning culture.

Argyris identified four gaps in the assumption that leadership automatically leads to an expected outcome in a learning environment (Argyris, 1992). He questions the assumption that individuals have the skills necessary to learn new behaviour and says that this assumption may not be warranted. He states that the people in a change process may be unaware of, or choose to stay unaware of, the lack of such skills and that this may be related to the suppression of feelings. One especially valuable insight from Argyris' work lies in the potential gap between espoused values (what people claim to value) and their theory-in-action (what people's decisions and actions reveal about their values).



### ***2.2.3 Shared, distributed, and parallel leadership***

In recent times New Zealand principals have been encouraged to embrace distributed leadership. Many writers support the concept of shared leadership (Copland & Knapp, 2007; Harris, 2008; Leithwood, Harris, & Hopkins, 2008), distributed leadership (Hargreaves & Fink, 2004), or parallel leadership (Crowther, Ferguson, & Hann, 2009) as a means of sharing the demands of the heavy workload imposed by self-management and administration systems. In the distributed model, leadership responsibilities are distributed to key stakeholders in the school. Elmore (2000) describes distributed leadership as “multiple sources of guidance and direction following the contours of expertise in an organisation, made coherent through a common culture” (p. 15), whilst Andrews and Lewis (2004) describe it as a form of parallel leadership. The theory of parallel leadership (Crowther, et al., 2009) blends strategic leadership by the Principal and senior leaders with shared leadership whereby teachers and the general school community are involved. This provides a clear role for the Principal within the context of a collaborative culture.

The National Quality Schools Framework in Australia (Department of Education, 2003) proposes that schools with shared leadership:

- Create and maintain a shared vision and goals for student development and learning;
- Empower staff to share leadership for school development that responds to and manages the processes that lead to sustained improvement;
- Create high expectations for students, teachers and school, with a focus on social, emotional and academic learning outcomes for all;
- Develop and maintain high-level, shared knowledge about curriculum and instruction; and
- Initiate innovation through a focus on action, culture building and organisation-wide learning.

In the distributed leadership model, leadership moves from control towards support and the building of capacity within the school system. When a principal distributes leadership responsibilities, he or she relies on actions by the group towards a well-defined end result. The Principal focuses on instruction but they do much of this through others, “not by distant delegation, but by fostering coalescing leadership in which combinations of leaders are working together on instructional improvement” (Fullan, 2008, p. 55). The Principal’s role is to ensure that the organisation heads towards an agreed goal in a productive way, utilising the full potential of the school community.

A lack of documented, widespread practice of distributed leadership suggests that it is still only one technique (Gronn, 2000) as opposed to being an observable, widely used, model in action. Research on the perceptions of principals on the practice of shared leadership reported that “while the rhetoric of shared leadership was prevalent in schools, there was very little evidence of its practice” (Duignan & Bezzina, 2006, p. 12). The respondents had crude understandings of what shared leadership was and failed to match ideology (espoused theory) with behaviour (theory in use). Simply because sharing or distributing leadership may be democratic and collaborative does not mean that it may be the best method. Writers (e.g. Mitchell & Sackney, 2000) question the applicability of distributed leadership across all contexts, asking whether such forms of leadership are easy to implement without a particular culture being in place. There is still little agreement as to how leadership is recognised and labelled within a distributed leadership setting when considered in the context of adults at work in schools. Power balance, organisational inertia, internal member conflict, and over-cautiousness could be detrimental yet still included within the distributed leadership system. This warrants more investigation (Harris, 2004).

A recent case study on school reinvention listed several drawbacks associated with shared leadership (Degenhardt & Duignan, 2010). One drawback was that too much involvement and a multiplicity of teams became a source of confusion and, paradoxically, reduced trust such as when someone else on the team adopted a leadership role ahead of another. Another drawback was that many teachers desired hierarchy, perceiving it as giving certainty in leadership, an observation made in other research (e.g., Brown & Anfara, 2002). When the Principal in the case study took an indirect role, staff saw this as an abdication of her responsibility, seeing the Principal as being more concerned with the 'study of reinvention rather than the reinvention itself' (p. 136). The Principal herself felt disconnected and struggled to define her role. When returning to more direct involvement, through parallel leadership, this was greeted favourably by staff.

#### ***2.2.4 The leader-middle management-teaching team relationship***

The mutual accessibility of leaders and teachers in a distributed, shared or parallel leadership situation needs careful management. When shared leadership is incorporated over an existing hierarchical structure it may lead to challenges when viewed from the perspective of Anderson's (2004) 'Model of Leadership Reciprocity'. Anderson describe three situations, the first of which is the 'contested model', the second is the 'buffered model', and the third being the 'interactive model'.

The "Contested Model", shown in figure 2.1, is where the Principal stands 'out of the loop' usually in formal leadership roles and in opposition to teacher leaders. The teacher leaders see themselves as "guardians of the established way, setting themselves up in opposition to the Principal" (p.110).

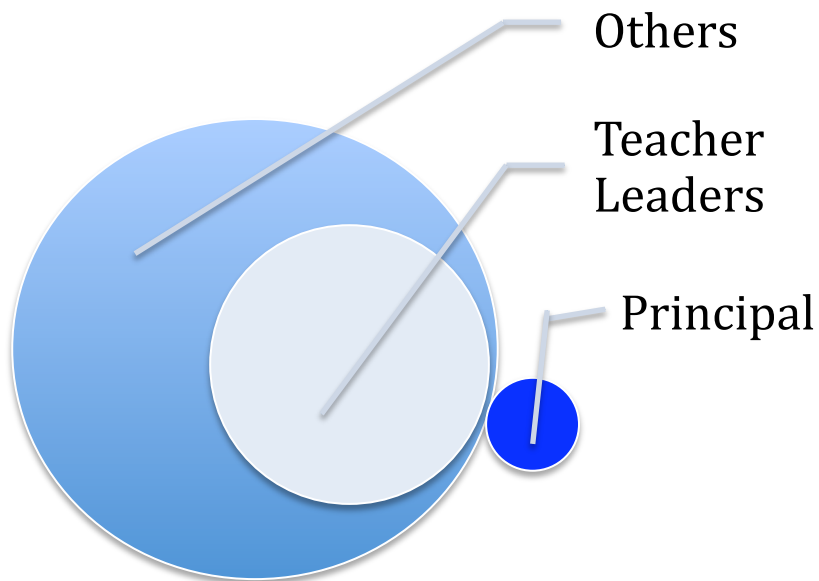


Figure 2.1: Anderson's Contested Model

Figure 2.2 shows the 'Buffered Model', where access to, and influence upon, others is mediated through the teacher leaders.

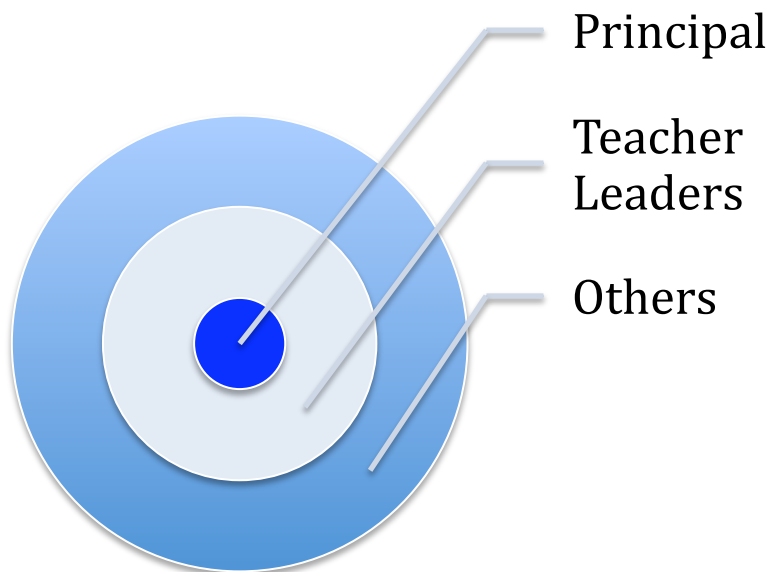


Figure 2.2: Anderson's Buffered Model

The final of the three models is shown in Figure 2.3 and is called the 'Interactive Model' where the Principal, teacher leaders, and other members of the school community share accessibility equally and communicate freely. This model accepts that each may have their separate roles within the model.

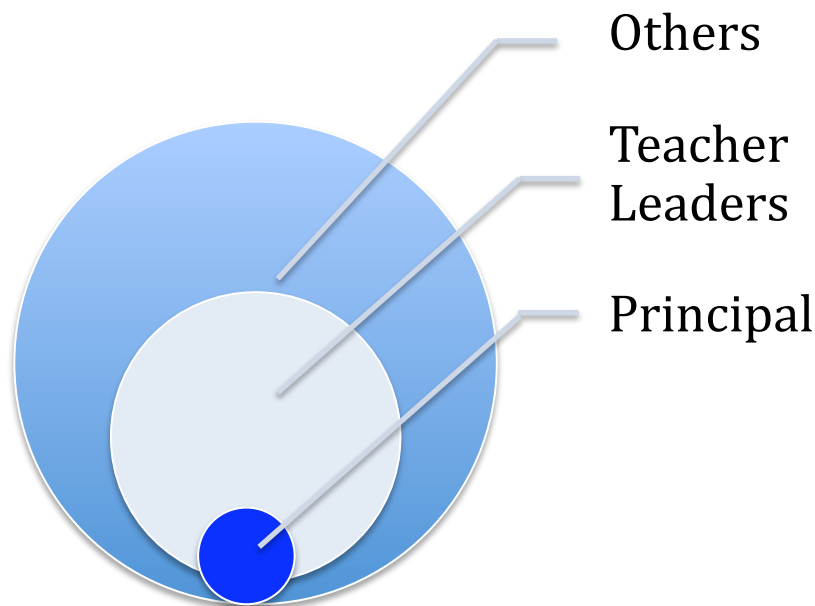


Figure 2.3: Anderson's Interactive Model

### ***2.2.5 The school leader's role in influencing classroom practice in mathematics***

How a principal influences classroom practice through provision of effective professional development, is a central focus of this study. The Principal must fully understand the impact they have on the organisation and the individuals within an organisation. The Principal has specific roles to play, in partnership with the school community, if they are to be an effective professional development leader. Lindstrom and Speck (2004) designate four roles:

1. Builder: Preparing the capacity by working with their teachers with the aim of building a professional learning community.
2. Designer: Learning about effective professional development and making decisions using the context and needs of the school.
3. Implementer: Taking action in facilitating change and knowing how and when to help initiate the appropriate changes at the correct time.
4. Reflective Leader: Evaluating results of professional development in order to identify any gap between expected outcomes and observed implementation derived from that professional development.

The core of building leadership and pedagogical capacity in schools lies in how the Principal focuses on the development of teachers' knowledge and skills (Newmann, King & Youngs, 2000, cited in Fullan, 2002, p. 16). Stewart, Duncan, and Prebble (1997) list "maintaining a programme of personal professional development" as one of the five important themes in educational and professional leadership (p. 202). Their own professional development should mirror effective professional development for teachers: It should be long-term and planned, focused on student achievement, job embedded, supportive of reflection, and provide opportunities to work, discuss, and problem solve with peers (Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2003, p.99).

This study examines mathematical identity and professional development in mathematics. It is therefore important to consider whether the mathematics-learning context warrants special attention. Research and scholarship on leadership seldom considers instruction in terms of subject specific contexts with leadership's affect on teaching and instruction most often considered as a generic construct whereby school leaders talk about educational leadership in "subject matter neutral terms" (Spillane, 2005, p. 387). However, Spillane's study unmasked substantial differences between subject areas in terms of leadership arrangements for mathematics, literacy and science. In mathematics-related leadership, there were fewer leaders involved when compared to literacy with Principal and Assistant Principal involvement more prevalent in literacy routines but with lead teachers taking the lead in mathematics routines. At one school, Spillane identified that "three or four formally designated leaders were always in attendance and more often than not actively involved in performing routines related to literacy. In contrast, for mathematics-related routines school administrators were not always in attendance, and when they were it was typically only one and they rarely contributed." (p. 388). Leaders viewed literacy as an area to be integrated through the curriculum and understood literacy as a measure of student progress. Mathematics, however, was about "having teachers follow the curriculum and achieve good test results" (p. 389).

Timperley, Wilson, Barrer and Fung (2007), in their meta-analysis of research on teacher professional learning and development, highlighted a lower profile for school leaders in professional development in mathematics than in any other curriculum area, “It may be that what was being asked was as challenging for leaders as for the participating teachers” (p. 75). In such circumstances, principals tend to limit themselves to ensuring a supportive environment in which the professional learning and its implementation take place (Schorr, 2000).

With sustained high-quality professional development, primary school principals can learn to coach or mentor elementary teachers effectively in mathematics (Nelson and Sassi, 2005). Nelson and Sassi demonstrate that if the Principal does not have a positive relationship with mathematics they will not be an effective educational leader of mathematics. They state that the nature of a principals’ mathematics knowledge “very much affects what they are able to appreciate about mathematics instruction in their schools” (p. 9). Principals in primary schools may be specialists in one curriculum area and generalists in others but the question of sufficiency often surfaces: “How much knowledge in any particular subject – and of what kind – is enough for administrators to be effective instructional leaders, especially with regards to decisions regarding instruction in that subject?” (p. 9). The knowledge that principals hold, in terms of mathematics education, will be reflected in how they approach the mathematical content and pedagogical improvement needs of their staff. Nelson and Sassi explain that many principals in their study did not have mathematics backgrounds or adequate mathematical knowledge.

Maintaining and extending current knowledge in mathematics is important in light of the dramatic changes effected from cognitive psychology and mathematics education research. The move away from individual work, led by textbook content, towards classroom discussion based on students’ own ideas and solutions to problems is now considered fundamental to children’s

learning (Wood & Turner-Vorbeck, 2001). This major shift in mathematics teaching practice was informed by the constructivist theory of Piaget and the socio-cultural theory of Vygotsky. It is not necessary to choose which of these to favour as they are both similar when considering practices that promote opportunities to construct ideas (Cobb, 1994). Even so, the need for participation by principals in personal professional development in mathematics is paramount in order to understand and implement the true aims of reforms, such as New Zealand's Numeracy Development Project. Such personal development activates an understanding of exemplary classroom practice as a basis for identifying professional development needs and the resources associated with it. Spillane's (2000) research on the barriers to implementation of reforms in the United States demonstrated how district leaders, including school and district administrators, curriculum specialists and lead teachers of mathematics, interpreted the reforms through different cognitive lenses than those of the policy makers. Local understandings were "demathematized" and "focused on piecemeal change... rather than an integrated reform plan or strategy" (p. 151). He goes on to say that most of the leaders in his study admitted weak understanding of mathematics and that, without principle-based understandings, the leaders would have been unable to construct understanding required by the reform. Spillane asks if it was reasonable to expect leaders "to develop rich conceptions of mathematics" (p. 169) and concludes that it is reasonable because of their role in selecting and organising professional development for teachers.

One way to improve both the Principal's knowledge and their influence on their staff's practices involves providing educational leadership whilst sharing in the learning about mathematics with the teaching staff. Being involved in the learning as well as leading instructional improvements means principals would need to have regular discussions with staff on mathematics, participate in the professional development opportunities offered, and create a culture of learning "that supports ongoing reflection and intellectual risk taking for all" (Nelson and Sassi, 2005, p. 169).



### ***2.2.6 The reflective leader and the ladder of inference***

Having considered research that principals apply different leadership structures and routines to mathematics and that less leadership profile is evident in mathematics than in other subjects, e.g., Spillane (2005) and Timperley and colleagues (2007), it is pertinent to examine how a principal may accurately assess the reality of mathematical classroom practice in their schools. This section examines the necessity of reflection and one of several reflection tools, the ladder of inference (Argyris, 1990).

The gulf between theoretical abstractions of academic leadership development programs and the daily lives of leaders makes deep reflection a crucial tool for leaders in order to learn from the challenges of leadership work (Reeves, 2006), irrespective of leadership style. A reflective leader incorporates a cycle of feedback and critical evaluation of their leadership practices, the practices of their team members, and the effects of any interventions on both themselves and others, allowing for the construction of connections and meaning. The resulting insight allows the Principal to share with others and clear up misunderstandings. “Too often there is not an established reflection and evaluation process in place to focus the efforts on what is being the clear effect on student achievement” (Lindstrom & Speck, 2004, p. 27).

Reflective leaders recognise a tendency to make claims about the world that they assume to be true and expect everyone else to accept the claims as if they were factual. A powerful tool to counteract this tendency the ladder of inference (Argyris, 1990), a model adapted and used by several researchers, e.g., Stone, Heen, and Patton (2010). Utilisation of the ladder allows a reflective leader to become aware of what led them to make their claims and of the possible ways in which their claims may be wrong, to identify other interpretations, become more open minded, and build

relational trust with people who recognise that the leader does not have a fixed opinion but is open to learn. Figure 2.4 shows the steps of the ladder:

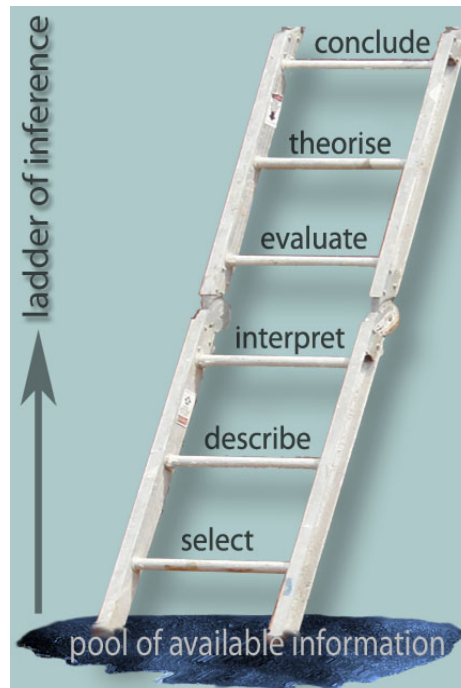


Figure 2.4: Ladder of inference as developed by Argyris (1990)

The pool of information at the bottom of the ladder represents the available information relevant to the situation being addressed. The rungs of the ladder represent the different types of claims that could be made about the information. The further the rung is up the ladder, the more inference is applied about the meaning of information and the more likely that disagreements will arise about the interpretation of the claim. That is why leaders need to be careful about how they climb the ladder of inference (Robinson & Lai, 2006). The first rung recognises that the leader has been selective about the information drawn from the pool and that other people may take different information into account. The second rung recognises that descriptive claims may not be as obvious to others. The third and fourth rungs consider the way people interpret and evaluate what has been noticed and described and recognises that context, values, and prior assumptions are powerful influences on interpretations and evaluations. The fifth rung considers the theory of action that has been created as a result of individual interpretations. The sixth rung represents the conclusions that arise from the theory of action and form the basis for any actions taken.

The recognition that participants in the same process, with the same pool of available information, may be on totally different ladders of inference is very powerful. Once this position is recognised the leader should stop climbing further up the ladder until they have investigated the source of divergence. Once understanding has been reached and claims revised the next rung of the ladder can be co-constructed.

### ***2.2.7 Summary of leadership***

School leaders have multiple and challenging responsibilities which have increased exponentially with the advent of self managing schools and increased pressure for centralised accountability. Administrative needs diminish the time and energy that can be directed towards educational leadership and transformational leadership. Leaders are now required to align all of a team's skill sets towards that goal through relational trust and shared, distributed or parallel leadership may be a suitable underpinning model. Relational trust can be improved by the use of the ladder of inference which allows participants to gain an understanding of how others reached a theory of action but, even in a shared leadership model, a leader must still be the lead learner in terms of pedagogy, knowledge of how learners learn, and understanding the specialised nature of mathematical content. The mathematical achievement of students depends on the Principal having a 'sufficient' level of mathematical and pedagogical knowledge of how students best learn and how teachers might best teach mathematics. This directly affects the practical judgement exercised in "teacher supervision, providing professional development for teachers, assessing students' and teachers' achievements, and interpreting and responding to parents' concerns about mathematics instruction" (Nelson & Sassi, 2005, p. 56).

The next section examines the concept of mathematical identity; how a person 'sees' himself or herself as having a positive relationship with mathematics.

## 2.3 Mathematical Identity

### 2.3.1 Definitions of mathematical identity

The concept of identity links the external and intrapersonal domains. Sfard (2008) refers to a combination of communication and cognitive psychology as taking the form of “thinking” and she combines the two terms into *Commognition*. Within this framework *identity* is a special case which takes place when “the discursive focus shifts from actions and their objects to the performance of the actions” (p. 290).

Identity has not only been approached from the psycho-analytic perspective but also from the socio-cultural (Boaler, 2002), the discursive (Morgan, 2009), and the post-structural (Walshaw, 2004). This variety of perspectives, or ‘conceptual multiplicity’ (Walshaw, 2010a), has led to Grootenboer and Zevenbergen (2008) defining identity as “how individuals know and name themselves... and how an individual is recognised and looked upon by others... (bringing together) elements such as life histories, affective qualities and cognitive dimensions.” (p. 243). The cultural or psychological interactions that affect a person’s method of relating to mathematics learning have been termed ‘*mathematical identity*’ (e.g., Grootenboer & Zevenbergen, 2008; Sfard & Prusak, 2005). Issues of inclusion and exclusion in mathematics are addressed by looking through the lens of mathematical identity. The concept of mathematical identity “posits that the teacher’s role is to facilitate the development of students mathematical identity by relationally bridging student and subject.” (Grootenboer & Zevenbergen, 2008, p. 243). It includes the broader learning environment and the personality dimensions that both student and teacher bring to a classroom. Mathematics education is therefore concerned with developing mathematical identity, whereby an individual may say that they have a positive relationship with mathematics. In order to be able to say this, a person must have not only mathematical skills and subject knowledge but, also, positive attitudes,

beliefs, and emotions if they are to have a positive mental *image* of mathematics and to identify themselves as having a positive relationship with the subject. Image in this sense can be defined as a mental representation, originating from experiences and associated with beliefs, attitudes and conceptions (Lim, 2002). Most definitions of pedagogy do not account for the way that relationships, personal opinion and emotional responses act as perceptual filters upon what is known and what is knowable.

Black and colleagues (2009) examine identity and participation from the socio-cultural, psychoanalytic and discursive perspectives. Researchers who utilise the socio-cultural perspective stress the impact of school and classroom practices on mathematical identity of the learner at classroom level and the subsequent level of proficiency. Discursive perspectives rely on the presumption that what is said and done makes up the identity and this is applied both at the individual level and at the level of curriculum documents (Morgan, 2009). The psychological perspective focuses on the individual with attempts to categorise aspects of identity or to create models that place the individual within a context. Psychoanalytic approaches are where the importance of the constituents of the 'self' (hopes, dreams, anxieties, and defence mechanisms) is considered the prime factor of identity. With at least two 'selves' involved in learning (the teacher, the student and others) egos need to balance the power relationship and thereby "surrender our need for control" (Bibby, 2009. p. 125). The psychological inputs are seen to override and affect the rational self to such an extent that the conscious and the "unconscious aspects of a mathematical experience" cannot be separated (Walshaw, 2010a, p. 427). Taking into account that pedagogy is problematic when defined as simply an activity that enhances learning, the psychoanalytical approach applied to pedagogic practices more align themselves with Dewey who defined pedagogy as "the interrelationships of persons" (Hickman & Spadafora, 2009). Relationships go further than the rational thinking and knowledge suggested by the highly valued teaching technologies of current pedagogical practice.

Sociocultural perspectives examine the interactions between the individual, culture and society. From this perspective identity is both internal and external to the individual. Identity is seen as affected by society with the individual attempting to 'steer' along society-provided "predefined passages" (Côté & Levine, 2002, p. 49). The post-structural perspective argues against identity formation being either individual or social. This perspective views identity formation as dynamic and somewhat unstable.

One extreme and negative effect on mathematical identity is *mathematics anxiety*. Causes and effects of mathematics anxiety are addressed in the next section.

### **2.3.2 Mathematics anxiety**

Mathematics anxiety has been identified as a learning difficulty for many children (Dossel, 1993) and also for primary school teachers. Hembree (1990) showed that pre-service primary teachers had higher levels of mathematics anxiety than any other major on American university campuses. Likewise, Carroll (2005) and Bursal and Paznokas (2006) state that these levels of anxiety can be directly related to low confidence in teaching primary school level mathematics and, as Askew and his colleagues (1997) suggest, may impact on the ability of teachers to teach mathematics effectively. More than half of all Australian primary sector teachers have negative feelings about mathematics (Carroll, 2005). Teachers with mathematics anxiety may unintentionally pass on these feelings to students (Wood, 1988).

Richardson and Suinn (1972) describe maths anxiety as "feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations" (p. 551). This definition highlights that mathematics anxiety affects a person at the cognitive, emotional and behavioural level. The

cognitive spectrum from success to failure will have a corresponding behavioural response, from pursuit to avoidance, and an emotional correspondence, from confidence to anxiety. Mathematics anxiety is exhibited as feelings of tension and worried concern that interfere with the manipulation of numbers and the solving of mathematical problems in a variety of life and academic situations.

The origins of mathematics anxiety lie in childhood experiences. Parents with math anxiety pass it to their children, while teachers with maths anxiety pass it to their students (Fiore, 1999). Jackson and Leffingwell (1999) concluded that instructors need to be aware of the fact that maths anxiety can last 20 years or more. The ability to get a correct answer in maths is seen as the end goal unlike in literacy where it is fine to skip a difficult part and return later. Ashcraft (2002) examines student avoidance resulting from “teachers who convey a very high demand for correctness but provide little cognitive or motivational support during lessons” (p. 184). This can be observed in teacher actions such as not responding to misunderstandings with any explanations, and holding students responsible for their lack of understanding. This reflects a behaviourist pedagogy, as promoted in New Zealand before introduction of the 1992 curriculum, and the pedagogical approach experienced by anyone who has not taught in the classroom since that time or did not undertake the professional development relating to the 1992 curriculum, such as the Numeracy Project.

Mathematics anxiety has an effect on the mathematical identity of teachers and influences how, and what, they teach and how their students feel about mathematics. Physiological studies of maths anxiety found that people who were math-anxious could not stop their working memory resources from being overwhelmed by task-irrelevant distractors. (Hopko, Ashcraft, Gute, Ruggiero, & Lewis, 1998). Ashcraft and Kirk (2001) concluded, “maths anxiety disrupts the ongoing, task relevant activities of working memory, slowing down performance and degrading its accuracy” (p. 236).

### **2.3.3 The Teacher's Mathematical Identity**

If we accept that the mathematics teacher has the goal of developing the students' mathematical identities, then we must also accept that the teacher must start the process with their own strong mathematical identity. As espoused above, this includes the possession of mathematical knowledge and skills as well as a positive attitude towards maths, and enjoyment of maths as an area of thinking. Mathematics should not be seen as an external entity by the teacher but as part and parcel of their cognitive and emotive being. Mathematical thinking is a verb and the teacher of mathematics should not fall for *reification* to turn it into an abstract noun (Sfard, 2008) as if mathematics were purely an inert body of information to pass onto students. Palmer (1993) talks about the relationship between the subject and the student being almost like a friendship. The teacher must feel so comfortable with mathematics that they introduce it to their students as if the teacher and it were valued friends and they, the students, were valued enough to be encouraged into that friendship. This is difficult if the teacher does not have a strong mathematical identity themselves, alongside a strong pedagogical relationship with students.

Teacher change can be conceived in terms of teachers constructing "narratives of professional identity" that draw upon experience in communities of practices (Schifter, 1996, p. 2). Schifter identifies the complexity of what makes a teacher's professional identity, "These teachers enact multiple identities: as mathematical thinkers, as managers of classroom process, as monitors of their students' learning, as colleagues, and as members of the wider education community. "Identities" in this sense - more a matter of what one does than who one thinks one is - are constructed in and realised through practices" (p. 2). It is important to note that Schifter conceives that a teacher's identity might be as a mathematical thinker, for example, but this could be used in a variety of distinct communities, including the classroom, planning sessions with colleagues, and professional development activities. In a reciprocal sense, the



mathematical identity of a teacher could be affected through professional development undertaken. Engaging with colleagues in mathematical professional development enables teachers to distance themselves from their identity as a classroom teacher, or other professional identity, and “to become aware of and reflect upon their activity and, thus, explicitly reconstruct their knowledge” (Millett, Brown, & Askew, 2007, p. 228). Millett and colleagues raise the need for deep reflection to enable teachers to actively develop their beliefs about mathematics and mathematics education.

As this paper is primarily concerned with school leaders’ and teachers’ mathematical identities, the range of interactions between teacher and students in the context of a mathematics classroom will not be addressed here.

It is this study’s position that mathematical pedagogy is fundamentally different from other subjects because the practices of mathematics are different to other curriculum areas (Grootenboer & Zevenbergen, 2008). It is also this study’s position that the improvement of mathematical identity in primary teachers, through the provision of appropriate leadership and professional development, could help resolve some of the issues and fill a gap in the research.

There is little, if any, research into how the chain links of identity are connected from one level in a school to another, i.e. from school leader to teacher to student. This is a gap in the research and this study is an initial attempt to examine the first of these links, from school leader to teacher.

## **2.4 Professional development in mathematics in New Zealand primary schools**

### **2.4.1 Introduction**

MacBeath and Dempster (2009) give professional learning a higher priority than children's learning, "as ignorance of how children learn and grow is maybe worse than no teaching at all" (p. 78). Teachers who don't acknowledge their role as learners when they are with their students send an implicit message about the "authority of knowledge itself" (p.78). One is left to consider that the message must be a negative one. According to the New Zealand Ministry of Education's Iterative Best Evidence Synthesis on School Leadership and Student Outcomes, a meta-analysis of leadership research (Robinson et al., 2009), the leadership dimension that produced the largest estimated effect size on student achievement is where the school leader is participating in, and promoting, formal and informal opportunities for teacher learning and development as leaders or as learners, or as both. New Zealand's Ministry of Education requires teachers to engage in professional development to develop "critical knowledge, skills and attitudes needed to perform a particular role effectively" (Ministry of Education, 1999, p. 4).

In this chapter we discuss specific research literature relating to professional development models and provision of mathematics professional development in New Zealand's primary school sector. The effectiveness and sustainability of such professional development in teaching mathematics is also reviewed.

### **2.4.2 The Purpose of Professional Development**

The paradigm for high quality, mathematical professional development has changed during the past decade. The 'knowing-doing gap' (also referred to as the 'expected outcome – actual implementation gap') describes the

separation between what professional development is expected to achieve and what school leaders are willing to accept in terms of implementation (Pfeffer & Sutton, 1999). Pfeffer and Sutton regard the “greatest mystery of organizational management to be the separation of what we know from what we do” (p.4). In the emerging paradigm of professional development, the term has been defined as “a comprehensive, substantiated, and intensive approach to improving teachers’ and principals’ effectiveness in raising student achievement” (National Staff Development Council, 2008, p.6).

A range of professional development options are available from one-off models through to ongoing professional learning groups. Each of the options have both advantages and disadvantages depending on the need and the ability of the teacher to learn in that particular way (Lauro, 1995). Professional development needs to meet the objectives and desired outcomes by influencing as many participants as possible. If the improvement of pedagogy is the desired outcome, professional development should be ongoing and offered through several means within the same program so that individual needs are met. This is one of the major contrasts between the old paradigms and the new paradigm of professional development: Professional development is not an event or ‘training’, it is ongoing, continuous, sustainable activities both inside and outside of the classroom.

Professional development encourages metacognition by teachers on their pedagogy and leads to a subsequent action plan for improvement helping the teacher to build a toolbox of approaches to teaching and learning, thereby giving sustainable pedagogical shifts (Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2003). Such improvements should be done collaboratively. Research indicates unequivocally that the “right kind of continuous, structured teacher collaboration improves the quality of teaching and pays big, often immediate, dividends in student learning” (Schmoker, 2005, p. xii). However, for long-term improvement to occur, the teacher’s own beliefs, perceptions, and understanding of the subject content and

pedagogy may be barriers that need to be overcome (Korthagen & Kessels, 1999). If teachers can see the relevance of professional development to classroom practice, they will “learn either to pursue the connections between teaching and learning with aggressive curiosity or healthy scepticism” (Little, 1982).

The professional development envisioned for mathematics teachers sees them collaborating to extend their knowledge of mathematics pedagogical content and skills with a further expectation that action based on that knowledge will be applied to classroom practice. Culturally embedded views of mathematics must be challenged by professional development (Ball, 1996). If these factors are not aligned, the teachers’ perspectives acts as a filter placed between the intended curriculum and the curriculum in action. To build teachers’ knowledge capacity and sustained implementation into classroom practice, professional development must provide great clarity and low teacher-to-teacher variance on the mathematics learnt. School leaders and teacher teams need to agree on assessment tools and then work collaboratively to ensure the quality and depth of teacher practice and assessments and professional development in mathematics should provide time, mentoring, and leadership so that teachers can reflect on student learning and data (Kanold, 2010). Pertinent to this study, it has been shown that the leader’s view of the subject influences any reforms, resulting in strategic resources being allocated depending upon the value attached to the subject (Burch & Spillane, 2003).

#### ***2.4.3 Implementation of mathematics professional development***

New Zealand’s Education Review Office report, Maths Now (2002) states, “too little is known about the pedagogical content knowledge of primary teachers, especially as they operate in a context where this knowledge is vital” (p.23). A key element in educational leadership, as well as in building collaborative learning, is the encouragement of Principals and other teachers to intentionally enter classrooms to gather information and support teachers

on an ongoing basis (Williams, 1996). It is important to separate classroom observations from classroom visits, particularly when done by school leaders. Classroom visits should be designed specifically to assess the degree of program implementation. This is different to conducting a teacher evaluation through a classroom observation. Such observations can last 45 minutes or more whereas classroom visits are used to gather information about types of instruction and the degree of curriculum implementation, are non-evaluative in terms of serving teachers, explores trends in cumulative rather than individual data, and seldom exceed 15 minutes in length. The two processes should not be confused as trust and cooperation are likely to be reduced and change efforts halted if a classroom visit results in teacher evaluation data (Lindstrom & Speck, 2004). Fink and Resnick (2001) identify that effective principals “are in teachers classrooms every day and it is difficult to draw the line between observations that have an evaluative intent and those that are part of the professional support system” (p. 606). Such visibility communicates the message that the Principal is interested and engaged in the daily operation of the school and allows for interaction between the Principal, teachers and students regarding substantive issues (Marzano, Waters, & McNulty, 2005).

The Principal has a direct role and needs to be knowledgeable about the professional development strategies with the greatest likelihood of success in improving student learning (Lindstrom & Speck, 2004). Teachers need opportunities to move from exposure to ideas, to exploring new techniques, implementing the techniques into classroom practice, being provided with ongoing support and coaching, and then sharing and reflecting. Alton-Lee and colleagues (forthcoming), reinforce this in their comments on a case study saying that teacher participation in a teacher study group, facilitated by an external researcher, was critical to the teachers’ success in this case. They add that, “This is consistent with the finding in the *Teacher professional learning and development BES* that teachers need opportunities to process their new learning with others a significant changes to occur” (p. 12).

#### **2.4.4 *Effective professional development***

Clarke (1994) developed ten key principles of professional development. Clarke's account was an early attempt to develop the idea that professional development was integral to improving mathematics education. For Clarke, reform meant changing professional development from a maintenance function to an enhancement function to improve teacher practice in mathematics. Professional development was seen as a partnership and whole-school approach, with integrated teacher reflection and an extended timeframe to allow inquiry into practice. There was also a call for professional development providers to evaluate implementation as it had previously been assumed that the provision of professional development would automatically mean improved outcomes for students (Clarke, 1994).

Current research suggests that the content, rather than the context, of the learning is most influential factor in determining whether professional development in mathematics will result in improved student achievement (Timperley, Wilson, Barrer, & Fung, 2007). Professional development lasting 14 hours or less showed no effect on teachers learning. The largest effect involved programs offering 30 to 100 hours spread out over 6 to 12 months (Darling-Hammond & Richardson, 2009). Research continues to address the challenge of increasing teacher diversity and to focus on what works, for whom, and in what context (Anthony, 2007).

A study of successful mathematical professional development in the New Zealand context examined the effectiveness of the Numeracy Development Project (NDP) (Higgins & Parsons, 2009). The NDP has been lauded as being successful in improving teacher knowledge and practice as well as raising student outcomes (Stevens, 2010). Higgins and Parsons say that a focus on three explicit ideas of the project "has enabled teachers to deepen their professional knowledge, change their instructional practice and improve their responsiveness to students' diverse learning needs" (p. 231). The authors go on to characterize professional development activities that

encourage change in instructional practice as having a focus on subject matter knowledge, an understanding of how students learn that subject matter, and how to convey content in meaningful ways.

Not all professional development will be equally effective. Table 2.1 illustrates types of professional development activities and the level of use and impact.

<b><i>Type</i></b>	<b><i>Length</i></b>	<b><i>Level of Use</i></b>	<b><i>Level of Impact</i></b>
One-off workshop or staff development meeting	Episodic	Awareness of new idea or strategy	Little or none Less than 5%
Series of workshops	2-3 days	Awareness, practice	Beginning use Less than 5%
Series of workshops	3 months - one year	And awareness, practice. Beginning implementation	Implementation Developmental level Less than 10 to 15%
Conference	Periodic	Awareness and sharing	Little or none Less than 5%
Practice, feedback, coaching	Ongoing	Ongoing coaching	Continued use 85% to 90% use
On the Job (embedded)	Daily	Research into practice	Inquiring into practice 85% to 90% use
Inquiry cycle action research	Ongoing	Research into practice	Study of issue Understanding

Table 2.1: Professional Development Processes: impact and use (Lindstrom and Speck, 2004, p. 57)

Professional development can stimulate change at a variety of levels. A single professional development session will give no indication as to the sustainability of the learning (Irwin, 1994) whilst Fullan (1992) says that systemic change can take 5 to 10 years.

Building a learning community that is engaged in professional development processes, that support a cycle of inquiry, increases the likelihood that successful change may be sustained (Lindstrom and Speck, 2004, p. 56). Timperley (2003) directs schools to moving towards developing strong professional communities within schools and away from external courses and workshops. In research that studied sustained change in practice,

specific characteristics of the professional development offered were highlighted. These characteristics included collegial collaboration with regular meetings with teams of teachers to plan and evaluate programs and continued support and commitment from a research team (Franke, Carpenter, Levi, & Fennema, 2001). The relevance of discussion and reflection within the team of teachers was connected to the participants' opportunities to make connections about their knowledge. In addition to the professional learning group approach, other types of professional development that may generate sustainable change include study groups, mentoring and coaching that provide collaborative opportunities (Franke, et al., 2001).

It is the school leader's role to support and develop appropriate programs for the staff in their particular context. If the purpose is simply to convey information to teachers, a one-day course may be effective. However, for sustainable change, follow up is vital. This follow-up may take the form of reflective practice and/or research interface. When a supportive school environment encourages reflective practice, researchers have noticed the efficiency of being part of a group. Reflecting within a team forced a culture of collegiality and collaboration and is more likely to encourage educators to be both learner and teacher (Darling-Hammond, 1994). Prompt feedback on ideas and issues relating to teaching practice maximises this effect (Little, 2003). Collaboration allows teachers to raise issues relating to their own classroom context whilst removing the isolation that separated classrooms may bring. This is particularly true for primary teachers where collaboration can offer support in curriculum areas that generalist teachers may lack confidence in, e.g., opportunities for experienced teachers to assist beginning teachers can occur if they meet in study groups (Arbaugh, 2003). As an educational leader, a Principal needs to collaborate with these study groups if they are to be informed of the classroom practices in their school.

Timperley and Robinson (2001) noted that interaction between teachers and external facilitators helped with data analysis and an appreciation of



alternatives. This academic interface allows research to become part of a teacher's everyday practice. Professional development and research should go together if programmes are to be effective in improving teaching (Schmoker, 2001). Professional development must be seen as a daily facet of teachers real work rather than presented as an episodic or one time event that is soon forgotten and, consequently, rarely affects learning (Lindstrom & Speck, 2004).

#### **2.4.5 Professional Development Approaches**

The development of professional development programs differs across schools. However there are three labels commonly used when discussing approaches to professional development: The holistic approach; the do-it-all approach, and; the smorgasbord approach (Wood, 2003).

##### **The Holistic Approach**

The holistic approach involves strategic management input. It is a planned approach designed to make best use of strategic resources. The professional development takes into account school development, curriculum development, management development, and personal development (Cardno, 1996). Individuals identify the type of professional development they need in accordance with the strategic goals of the school. The school makes a commitment in terms of time and finance. Lauro (1995) calls this approach the comprehensive approach and identifies its effectiveness as a result of consistent professional development sessions that focus on goals and objectives. Continuous evaluation of the programme is necessary to make sure the goals are being met in line with the strategic direction of the school.

##### **The Do-it-all Approach**

The do-it-all approach, as the name implies, is based on the philosophy that the more professional development a teacher has then the better that

teacher will perform. In reality, such an approach can lead to work overload with unsustainable outcomes.

### **The Smorgasbord Approach**

This approach to professional development gives individuals a predetermined budget to meet their needs. Individual choice is encouraged. The amount of information an individual can receive is large but courses are expensive and the choice of which information to pass to other staff is made by the individual receiving the professional development. In addition, there is “seldom any connection between the evaluation of performance and developmental activities chosen” (Cardno, 1992, p. 19). Without a strategic intent, the range of programmes undertaken may be focused on particular members of staff and without reflection on the school’s professional development needs. Schools where one-off sessions occur frequently or conferences are attended without alignment with the school’s strategic plan of intent are exhibiting the smorgasbord approach.

Professional development is important to success but leaders and teachers must be sceptical consumers (Reeves, 2006). “Research suggests that when professional development efforts are focused on a few key elements, the yield in student achievement is significantly greater than when professional developers yield to the ‘flavor of the month’ approach in which fads replace effectiveness” (p. 79).

### **2.4.6 Professional development summary**

Professional development is an essential precursor of school improvement. Elmore (2004) explains that professional development stimulates and supports site-based initiatives if it models constructivism, engagement with ideas, respects teacher professionalism, is grounded on knowledge about teaching, and allows sufficient time for implementation and integration into practice in the classroom.

Effective provision of mathematics professional development requires school leaders to understand that the knowledge capacity of every teacher matters. It then falls on the shoulders of every teacher to act on that knowledge and implement it into classroom practice. It is essential that principals close the gap between the expected outcomes of professional development activities and the acceptable level of implementation as a result of the learning. This is measured by monitoring classroom practice. As the educational leader of a school, a principal must understand what should be taught in mathematics, how that is to be assessed, and what interventions are being applied for students who are struggling. With specialised content and pedagogy to consider, the Principal must have quality knowledge of mathematic pedagogy if they are to know whether their students needs are being met.

This literature review examined the types and availability of professional development in mathematics in New Zealand. These have been discussed within a social constructivist paradigm. The review has also included the requirement for school leadership, particularly through the Principal as lead learner, to set school strategic goals and to promote and participate in professional development designed to achieve the strategic goals. Mention has also been made that the attitude of the Principal towards the subject area concerned may affect professional development provision. Ideas raised form frames within which to consider how professional development can best be delivered or hindered by a school leader with a particular perspective of mathematics education.

## **CHAPTER 3: METHODOLOGY**

### **3.1 Justification for methodology**

After consideration of both the context of this thesis and of a variety of research methods, a qualitative approach was selected as the most appropriate. The context is that this study aims to explore teacher perceptions of principal leadership and provision of mathematics professional development.

The term qualitative research encompasses a range of research methods covering a number of forms of inquiry, including: grounded theory; interpretive research; case study; field study; naturalistic inquiry, and; ethnography (Merriam, 1998). Merriam contends that qualitative methodology in education tries to understand phenomena, processes or perspectives of the participants concerned and then interpret the data from the perspective of the participants and the researcher. A variety of research techniques can be used in qualitative research, including but not restricted to: questionnaires; surveys; observation; document analysis, and; interviews (Merriam, 1998). The product is a mix of description and analysis, influenced by critical and interpretive theories of inquiry.

A psychological perspective views constructive mathematical activity as resulting from individual student activity. A social perspective holds the view that the constructive outcome is socially situated. Cobb argues that each should balance the other towards an “emergent perspective” (Cobb, 2000, p. 307) and a cycle whereby theory emerges cyclically from practice and then further informs practice. This study was from the perspective of the individual teacher within the naturalistic context of a school community. The provision of professional development was placed in an ‘emergent perspective’ which assumed reflexivity between teacher self-concept relating to mathematics and the provision of professional development participated in.

A survey approach was used for this study. Burns (2000) describes surveys as tools that can collect data from simple descriptive data to the use of complex exploratory tools to examine beliefs and perspectives. "The survey approach is a research strategy, not a research method. Many methods can be incorporated in the use of a social survey" (Denscombe, 2006). The types of survey listed by Denscombe (p.7) are postal and Internet questionnaires, face-to-face interviews, telephone interviews, documents and observations. This study utilised a mixed methods approach with an Internet questionnaire (with a postal option offered) and follow-up, face-to-face interviews to support the triangulation of data.

### **3.2. Validity and reliability**

Quantitative researchers sometimes claim that qualitative research lacks scientific process and the ability to validate and secure reliability is challenged (Merriam, 1998, p. 200). Reliability is the ability to repeat research findings in various contexts but Tolich and Davidson (1999) stress, "reliability is not the goal" (p. 33). The goal in qualitative research is to achieve dependable results and this is done through ethical and well-documented procedures, a statement of the researcher's position, triangulated results, and an audit trail (Merriam, 1998). This study matches these requirements.

The question for qualitative researchers is, "how can reliability be achieved?" Merriam (1998) answers this by acknowledging that the individual's experience will influence the interpretation of reality as there are no benchmarks and further studies will not replicate findings in a quantitative manner. The reliability of a study is, "whether the results are consistent with the data collected" (p. 208).

Burns (1997) identifies two aspects to validity in research. These are internal and external validity. Internal validity reconciles reality and the research

findings (Merriam, 1998). To be internally valid, a study needs to reflect confidence that the responses from participants and the analysis by the researcher are true for those involved. For this to happen, the researcher and participants should share a common understanding. In this current research, the researcher is a current classroom teacher (of maths and other curricula areas) and has direct experience with professional development both as a participant and provider. Subsequently, not only are the factual details of interviews and questionnaire replies considered but, also, the researcher's knowledge of professional development provision in maths. Should data show inconsistencies, it is the researcher's responsibility to provide "plausible explanations about the phenomena being studied (using) the data at hand with a holistic understanding of the specific situation and general background knowledge" (Mathison, 1988, p. 17).

This study elicited principals' and teachers' perceptions on the provision of mathematical professional development and the mathematical identity of the school leader. Data was collected through multiple approaches: A principal's questionnaire (see appendix D); a teacher's questionnaire (see appendix E); principal interviews (appendix F), and; focus group interviews (appendix H). Primary school principals' views on their mathematical identity, their own professional development in mathematics and their leadership of mathematics in their schools were sought by use of the questionnaire and interviews. Teachers within their schools used a separate questionnaire to elicit their views on the provision and effectiveness of professional development in mathematics and their perception of the leadership applied by the school Principal. Focus group interviews followed to clarify these views. Consequently, the researcher had an opportunity to develop a deeper understanding of the perceptions of principals and teachers and, also, to provide a comparison of perspectives.

### **3.3 The dilemma of generalisation**

Qualitative research seeks to examine and explain aspects of social consequence and researchers rely on making generalisations. However, there is a dilemma that people are different and neither their actions nor the social world are transparent. A researcher is more than likely to have a different set of values to their research subjects, see the world in a different way and act differently, according to their beliefs, values and assumptions (McManus, 2010).

“Social research can never be entirely objective, itself being conducted within a social and political context” (Tarling, 2006, p.162). This lack of objectivity raises the dilemma of how to negotiate differences that will allow generalizations. Inappropriate generalisation leads to biased research when a researcher assumes that the findings from one group can be generalized without reflexivity onto others. Reflexivity in the research process means an awareness of our own and other world-views and their influence over the research undertaken. One way to foster reflexivity is for researchers to “question one's own assumptions and to work to make your values an explicit part of the process” (Tolich & Davidson, 1999, p. 65). The researcher is aware of the influence of his school education in mathematics, the fact he has little mathematics anxiety at his teaching level, and his expectations around the provision of effective professional development. He reflects that voicing his opinion with the respondents could influence the data analysis.

In this study a snapshot of perceptions of mathematical identity and mathematics professional development is offered, contextual to each individual's point of view, and the themes that emerge are descriptive. For these reasons the researcher acknowledges limited application as a generalized concept but it does offer principals and teachers some insights into how mathematical identity may affect the provisions surrounding effective mathematics professional development.

### **3.4 Ethics**

Research is the subject of ethical considerations and is subject to principles, rules and conventions (Anderson 1990). This research project upheld the Massey University code of Ethical Conduct for Teaching and Research (Massey University, 2001). The ethical standards, including key principles of informed consent, confidentiality, truthfulness, social-sensitivity and minimising harm, were all upheld throughout the process for all parties; school, principal, and teachers.

This study included, in moderate amounts, ethical dilemmas that are more frequent in qualitative research than in more traditional forms of research (Merriam, 1998). Anonymity between participants was an issue, as the Principals knew that their teachers were taking part in answering questions relating to them. Potential harm was minimised by maintaining anonymity throughout the study, not reporting identifiable features and using aggregated data. Other than this, the ethics application was considered to be low risk, Steps taken towards maintaining ethical principles included:

- i. Approval being sought from the Human Ethics Committee, Massey University
- ii. Approval sought from the Principals of the schools involved to conduct the study through themselves and volunteer teachers.
- iii. Information supplied to the participants, outlining informed consent procedures and advising them of the purpose of the study and their right to withdraw at any time.
- iv. An assurance to protect the identity of individuals and schools during the research and at publishing.

### **3.5 Data collection methods**

Consistent with an interpretive approach, data collection and analysis had complementary roles with each activity informing the other “as an iterative and reflexive process” (Tolich & Davidson, 1999, p. 108). Data collection



instruments appropriate for this study are the questionnaire, interviews and focus group interviews, and the researcher.

### **3.5.1 *The questionnaire***

The questionnaire is a common qualitative data collection tool. It asks set questions and the responses are assessed. Questionnaires can cover a wide range of data, such as descriptive data using close questions or open-ended questions which seek to extract ideas and beliefs. The use of the questionnaire allows efficiency and timeliness as it is easy to administer and can produce a large number of responses (Burns, 1997). It allows the same questions to be posed to a number of participants whilst guaranteeing the participants confidentiality, which encourages more honest responses. In this study, participants were offered the choice of a postal questionnaire or an Internet-based questionnaire, which allowed participants to set their own timeframe for answering questions, albeit that the researcher asked for returns before a due date. Interestingly, all participants completed the online questionnaire, which may indicate their comfort levels with ICT-based surveys or their perception of the time needed to complete the questionnaire.

A questionnaire (Appendix C) was designed to provide data on principals' self-perceptions and on their mathematical identity, their leadership of mathematics in their schools, and issues relating to professional development in mathematics. A second questionnaire (Appendix D) was designed to provide data on teachers' views on their school leader's mathematical capabilities, their own mathematical identity, and the provision of professional development in mathematics. Both questionnaire designs offered both closed and open-ended items. The questionnaire was self-administered and designed to elicit information about the Principals' role in the provision of effective mathematics professional development and the teachers' perceptions of that provision and the effectiveness of the Principal's leadership in mathematics education. In particular, the questionnaire provided information on:

- Personal details, in terms of age, time in role and experience as a Principal or teacher, and mathematical qualifications.
- The self-perception of participants in terms of mathematical identity
- The self-perception of the respondents in the mathematical context
- The nature and extent of mathematics professional development offered to staff

Additional areas that were addressed were:

- Perceived effectiveness on professional development methods
- The type of leadership of mathematics utilised by the Principal from their own point of view and that of their staff.
- Barriers to the provision of professional development

Gathering information on the participants' self-perception in terms of mathematical identity initiated a search on several methods of relevant data collection that could be used in a questionnaire format. The widely used Mathematics Anxiety Rating Scale (Richardson & Suinn, 1972; Suin & Winston, 2003) measures students' mathematics related anxiety but fails to assess other relevant dimensions of mathematics value and is cumbersome in the context of a wide-ranging survey. Subsequently, the Mathematics Value Inventory (Luttrell, et al., 2010), was selected and adapted for as a self-report inventory that measures individual differences in perceptions participants hold of mathematics interest, utility, need for achievement, and personal cost. The Mathematics Value Inventory (MVI) reveals positive and negative feelings towards mathematics, giving indications of strong or weak mathematical identity or anxiety to be further investigated in interview.

Exclusive use of questionnaires has limitations: The length of the questionnaire and the depth of answers required can affect the response rate in respect of each question; responses cannot be followed up due to the confidentiality of the questionnaires; the participant must understand each question; the honesty of responses may or may not be trustworthy, and; the manner in which the question is posed must be assumed to be the same as that in which it is read.

### **3.5.2 Interviews**

The interview, as an investigative tool, was applicable within the constructivist paradigms of this research project. Interviews allow for collecting data that would be inaccessible through the pure use of questionnaires as they enable the researcher to question more deeply and clarify issues raised in the questionnaires. Interviews were recorded with a digital audio recorder and wholly transcribed.

The use of interviews offers flexibility for the researcher to delve deeper for richer meanings than can be obtained purely by questionnaire. Kvale (1996) says that an interviewer should be a 'miner' (p. 3) or 'wanderer' (p. 5) and should use a conversational approach to elicit participants' "stories of their lived world" (p. 5). However, the balance of talk in an interview is different to a conversation in that the interviewer needs to listen more closely and promote participant talk (Babbie, 2010). This was an important consideration in this research as the interviews supported the researcher's intention to understand the Principals' and teachers' mathematical identities from their own perspectives.

The reliability and validity of interviews is in dispute due to the open-ended nature of questioning techniques (Truran & Truran, 1998). Truran and Truran also argue that reliability and validity "must be assessed in terms of the way the information is used and the nature of knowledge claims made" (p. 63). It is proposed that this research project has used interviews correctly under this argument.

The researcher chose to interview individual principals and to interview teachers in groups, using focus groups. A focus group brings together a number of individuals to discuss a common topic (G. Anderson, 1990). The interview is semi-structured because, although the interview centres on a topic, it is conducted in a setting that is comfortable for the participants and allows flexibility on the progress of the discussions. It allows an individual a

choice to explain or clarify their point of view or to make no response at all. It also allows other members of the group to develop issues that others have raised. This is an advantage when working with teachers as interactions lead to a wealth of ideas and increases flexibility whereby the parties “generate and answer research questions” (Morgan, 1997, p. 18). The data collected from focus groups complement the data collected from the individuals through questionnaires. Morgan (1997) notes that a focus group interview is limited to verbal behaviour and leads to difficulty in identifying interactions within the group. The interaction between the researcher and the group may also lead to bias. Another limitation is the time it takes to conduct the interview and the expense in time and resources of arranging focus group interviews when compared to a questionnaire (Burns, 1997).

This research project use both interviews and focus group interviews to develop the issues that have been raised in the questionnaires (Appendix E).

### **3.5.3 *The researcher's role***

Although the perspective of principals and teachers were central to this study, the researcher, as the primary instrument for collecting and making meaning of that data, was central in its outcome and any potential bias should be stated explicitly (Merriam, 1998). Current experience of teaching mathematics to students in the primary sector and developing personal mathematical knowledge through in-house and tertiary professional development meant that the researcher had realistic expectations of effective professional development in mathematics. He also had expectations of the Principal as lead learner and knew that the Best Evidence Synthesis on school leadership and student outcomes (Robinson, et al., 2009) showed that the highest effect size a school leader could expect was from promoting and participating in professional development opportunities.

By its very nature, qualitative analysis incorporates subjective assessments by the researchers who can never honestly be neutral (Creswell, 2009). Through the conscious awareness that this may be so, this researcher did what Tolich and Davidson (1999) describe as metaphorically wearing two hats. The identity of a teacher needed to be consciously replaced with the clearly defined role of the researcher in order to remain objective.

### **3.6 The research setting and sample**

The research was conducted at primary sector schools on the North Shore and West of Auckland, first contacted by telephone to gauge interest in participating. This was followed by e-mails to the Principals of eight schools detailing the purpose and requirements of the study and requesting an intent to participate' (Appendix A). Initial expressions of interest were received from eight schools but coincided with Ministry of Education requests for National Standards professional development and information. Consequently, the researcher did not think that enough attention would be given to this study when competing tensions were involved and four schools were eliminated from the research as a result.

The use of a questionnaire for this project allowed the researcher to obtain responses from a large number of primary teachers and four Principals. A follow-up e-mail had the Principals' questionnaire attached as well as a hyperlink to the online version of the questionnaire. There was an offer of mailing the hard copy version. All of the Principals completed the online version of the questionnaire and agreed to canvass their staff for people willing to participate in completing the teachers' version of the questionnaire. In all, four Principals and forty-nine teachers replied via online survey. The responses were analysed for significant similarities and differences. Two schools were then chosen as the best examples for case study comparison. The sample size for these two schools included two Principals and 36 teacher respondents. Due to the possibility of identification of the schools, numbers of staff from each site are not provided but both schools had a

participation rate of approximately 60% of their total staffing. This was due to the Principals' wish to make participation voluntary and through self-selection whereby some non-classroom teachers exempted themselves from the survey. All respondents answered every question. The data was codified into different categories to reflect both quantitative and qualitative data. Some individual responses are included, from comment boxes, where needed to expand a viewpoint.

These two comparison schools were selected to reveal the distinctly different ways in which the school leaders exhibited leadership of professional development for mathematics, influenced by contrasting mathematical identities. The types of professional development engaged in and the teachers' perceptions of both leadership and the provision of professional development in mathematics were also in direct contrast.

Due to confidentiality issues and the aggregation of data, one disadvantage was the inability to explore the individual responses for clarification. In order to 'drill-down' further into the Principals' and teachers' perceptions of mathematics professional development and the leadership thereof, the researcher conducted a number of individual and focus group interviews. These interviews were based in the primary schools selected. The case study schools provided a range of factors including roll size, year levels, staff experience, and decile. In each case there was an individual interview with the Principal of the school and a group interview with up to five staff. The interviews were recorded on digital voice recorder and the researcher transcribed and analysed the audio recordings.

### **3.6.1 Overview of School A**

School A is a suburban primary state school. The ethnic composition consists of a majority of New Zealand European students with Maori students accounting for 5% of the student population. Other ethnic groups account for between 1% and 9%, each of the student population originating

from South Africa, Great Britain, China, Korea, Southeast Asia, and a small percentage of other ethnicities. Principal A holds a non-teaching role.

### **3.6.2 Overview of School B**

School B is a suburban primary state school. The ethnic composition consists of a majority of New Zealand European, with Maori students accounting for 3% of the student population. Other ethnic groups account for between 11% and 4%, each, originating from Korea, Great Britain, Africa, China, Southeast Asia, and a small percentage of other ethnicities. Principal B holds a non-teaching role.

## **3.7 Data analysis**

Data analysis was framed to evaluate the data separately, assessing the results from each tool: The Principal questionnaire; the teacher questionnaire; Principal interviews, and; focus group interviews. The initial questionnaires were coded and common themes and areas needing clarification development formed the basis of the subsequent interviews.

The data was codified into different categories to reflect both quantitative and qualitative data. The coding of the themes in questionnaires was done via a spreadsheet. The codes were based on the researcher's interpretation of how the question related to particular themes, although the codes were adapted as clarification was sought and interpretation differed. The categories are as follows:

- Demographic data (quantitative)
- Participants' level of responsibility for mathematics education
- Participants' personal mathematical education
- Maths anxiety levels
- Overall professional development received over the previous three years

- Importance of professional development in maths as part of the appraisal system
- Type of any mathematics professional development participated in or facilitated
- Impact of mathematical professional development on the participant and their practice
- Effectiveness of professional development
- Perception of their Principal's participation in professional development in mathematics
- Type of leadership in mathematics exhibited by their Principal
- Effectiveness of the leadership in mathematics exhibited by the Principal

From these categories, data was summarised using descriptive statistics. As the data contained in interviews is firmly based within the schema of the person voicing the opinion, direct quotations are used in order to avoid researcher distortion. This is to differentiate between the words spoken and the interpretation made by the researcher.

### **3.8 Summary**

A qualitative approach was selected as the most appropriate method of obtaining data that will provide answers to the research questions. Qualitative data is particularly useful when research needs to find out why people engage in certain beliefs, values and assumptions. For this study, a survey research design was supplemented by interviews to explore primary principals' and teachers' perceptions of the provision of mathematics professional development in view of the mathematical identity inherent in the Principal and the issues surrounding this.

Reflexivity in the research process requires an awareness of our own and other world-views and their influence over the research carried out. Therefore the study was performed in a clearly documented and ethical



manner. The data collection techniques used are: a principal questionnaire; a teacher questionnaire; individual interviews with principals; and focus group interviews with teachers. The data was analysed by the researcher using a grounded approach of identifying codes, categories, and themes that were then used in conjunction with dialogue and quotes from participants.

This chapter has discussed the theoretical framework within which this research is based. It is also described, in detail, the steps undertaken in this particular case study as it considers the impact of school leaders' mathematical impact on the provision of professional development in mathematics. Chapter 4, which follows, outlines the findings of this research in narrative form and attempts to describe the nature of a school team's mathematical identity, leadership and the interplay between the two.

## **CHAPTER 4: FINDINGS - SCHOOL A**

### **4.1 Introduction**

The responses have been separated between the two schools. This chapter presents the findings from School A and the next chapter with School B. For reasons of confidentiality and ethical research, details that could help identify schools or individuals have been omitted. The Principal of School A will be designated 'Principal A' and that of School B, 'Principal B'. The number of respondents represents 60% of the total teaching staff at School A. As explained in Section 3, sample size is not provided to prevent school identification.

### **4.2 Teacher Profiles**

The first section of the questionnaire examined age range, experience, and years in their current position. The second section of the profile concerned the mathematical qualifications held by the respondents, whether they had taken part in a professional development contract for mathematics, including the Numeracy Project (as the largest recent professional development offered to schools), and their previous responsibility for mathematics as a department.

#### ***4.2.1 Age and experience***

The ages of the respondents were collected to give an insight into the respondents' likely beliefs towards mathematics as influenced by the way they themselves were taught. The age ranges for teacher respondents from School A are shown in Figure 4.1.

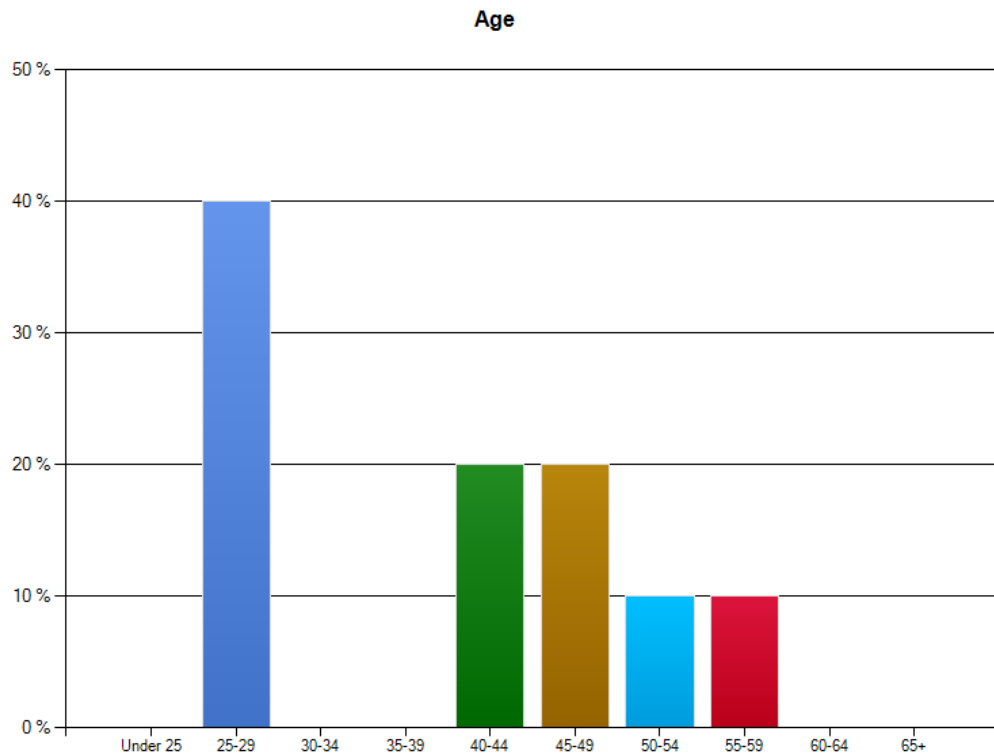


Figure 4.1: Age of Respondents

Two groups can be discerned; people between 25 and 29 make up 40% of respondents from School A, and the remainder are between 40 and 59.

The experience of the teachers was recorded in terms of years as a teacher, not only in their present school. 40% had 3 years, or less, experience, 20% had between 4 and 10 years experience, 10% had between 11 and 15 years experience, 20% between 16 and 20 years experience, and 10% had over 20 years teaching experience, with the highest in the group being 33 years. The time 'served' in their present school ranged from one to nine years. This question was included to address concerns around a lack of time to gain an impression of the educational leadership of the school, to appreciate professional development expectations, or to have an accurate perception of leadership or Principal A's approach to mathematics. One of the respondents was the lead teacher in mathematics.

#### **4.2.2 Mathematics qualifications, mathematical professional development and mathematics identity**

Principal A did not formally study mathematics beyond secondary school, completing university entrance as the last formal learning of mathematics as a student. Neither had the Principal completed any further qualification that included a mathematics or mathematics education component. Principal A described their history as a mathematics student:

*I have got a lot more confidence now than I used to have... I am one of those kids who didn't get it at school and I know what that feels like. 10 years later when I wanted to do teacher training and I was 1 point off an A.... and it all fell into place.*

Clearly, the statement provides evidence of a weak mathematical identity as a school student. However, it became clear, through interview, that this identity was repaired when entering the teaching profession, through opportunities in a teacher education program. Principal A also reported that, as a teacher, they had taken part in a Ministry contract for the New Zealand curriculum and was provided with professional development in the Numeracy Project. This professional development, combined with negative childhood memories of mathematics, gave Principal A an insight and increased understanding into students who struggle to understand mathematical concepts:

*I sympathise with those (children) who are struggling because I know what that feels like. They are trying really hard but it doesn't make sense... I can say to the staff that it's not that they are not trying, they don't get it. You have to try teaching in a different way. You've got to change your teaching and try something different because it's not working for those children.*

The teachers' qualifications in mathematics varied. 50% had not studied mathematics beyond high school. 50% had studied mathematics as

University undergraduates (predominantly in statistics to assist in evaluation for humanities papers). This is shown graphically in Figure 4.2.

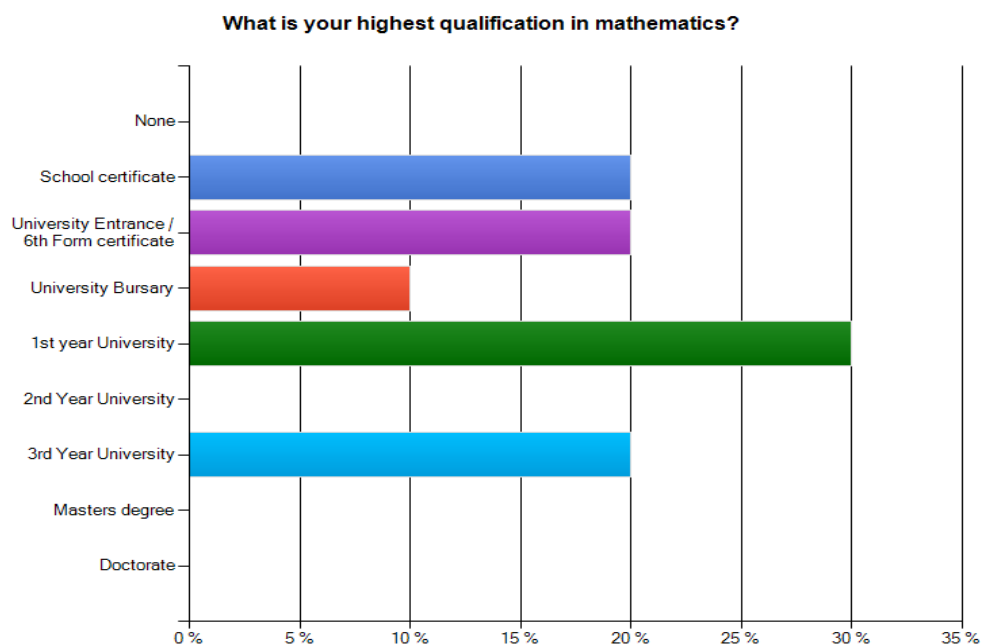


Figure 4.2: Highest qualification in mathematics.

60% of School A's respondents had participated in a Ministry contract for mathematics in the New Zealand curriculum. 100% had received professional development provided in the Numeracy Project. A teacher explained:

*All newly employed teachers receive an intensive introduction to the Numeracy Project and then join the whole school professional development program to improve their knowledge further.*

Through this statement the teacher demonstrated that they understood the need for on-going professional development in mathematics for it to be effective.

### 4.3 Assessing mathematical identity

Using the Mathematics Value Inventory (MVI) as a basis (Luttrell, et al., 2010), questions were posed about Principal and teacher attitudes towards

mathematics. Respondents rated their feelings on a five-point scale, ranging from strongly disagree to strongly agree. Table 4.1 shows collated responses. A coloured letter ‘P’ indicates the Principal’s answers. Agreement with statements 1 to 10 (shaded blue) indicates negative feelings towards mathematics and agreement with statements 11 to 19 indicates positive feelings towards mathematics.

		Strongly disagree	Mildly disagree	Neutral	Mildly agree	Strongly agree
1	There are almost no benefits from knowing mathematics	100% P	0.0%	0.0%	0.0%	0.0%
2	I see no point in being able to do maths.	100% P	0.0%	0.0%	0.0%	0.0%
3	Having a solid background in mathematics is worthless	100% P	0.0%	0.0%	0.0%	0.0%
4	I have little to gain by learning how to do maths	100% P	0.0%	0.0%	0.0%	0.0%
5	I do not need maths in my everyday life	80.0% P	10.0%	0.0%	0.0%	10.0%
6	Calculating my school budget is stressful	50.0%	20.0%	30.0%	0.0% P	0.0%
7	Maths activities scare me	40.0%	30.0% P	20.0%	10.0%	0.0%
8	Trying to do maths causes me a lot of anxiety.	30.0%	40.0% P	20.0%	0.0%	10.0%
9	Mathematical symbols confuse me.	20.0% P	60.0%	20.0%	0.0%	0.0%
10	Solving math problems is too difficult for me.	30.0%	70.0% P	0.0%	0.0%	0.0%
11	Understanding maths has many benefits for me.	0.0%	0.0%	0.0%	30.0%	70.0% P
12	I would be upset to be seen as “average” in maths	0.0%	10.0%	20.0% P	50.0%	20.0%
13	Doing well in courses involving maths is important to me	0.0%	10.0%	20.0% P	30.0%	40.0%
14	I find many topics in maths to be interesting	0%	10.0%	0%	20.0%	70.0% P
15	Solving maths problems is interesting for me.	0.0%	10.0%	0.0%	50.0%	40.0% P
16	Mathematics fascinates me.	0.0%	10.0%	30.0%	40.0% P	20.0%
17	I am interested in doing maths problems.	0.0%	10.0%	10.0%	50.0% P	30.0%
18	It is fun to do maths	0.0%	10.0%	0.0%	50.0%	40.0% P
19	I find maths intellectually stimulating	0.0%	10.0%	0.0%	20.0% P	70.0%

TABLE 4.1: SCHOOL A: MATHEMATICS VALUE INVENTORY SCALE RESPONSES

In this section I will discuss Principal A’s responses to the Mathematics Value Inventory (MVI) and their further explanations provided in interview.

Discussion of the teachers' responses on the MVI and interview responses will follow.

In statements of negative MVI indicators (statements 1 to 10) Principal A showed that they held positive feelings towards mathematics, clearly recognising the importance of mathematics as a subject area and life skill, although describing having a poor mathematical identity as a student. For the positive MVI indicators (statements 11 to 19) Principal A also showed positive feelings towards mathematics although they were neutral on two indicators. Many times during interview the Principal reflected negatively on their learning experiences in mathematics. It was evident that childhood memories of prescriptive rote learning of mathematics had influenced how Principal A identified with mathematics:

*At primary school there was a lot of rote learning and copying from the board... There wasn't a lot of equipment (or) hands-on activity where you actually do things. There was a lot of writing and textbooks. I can remember being stood up to recite times tables in front of the class and we used to do them forwards and backwards up to 12 but that didn't allow me to apply that knowledge to anything else. That was okay, because I wasn't in trouble.*

The poor mathematical identity remained until Principal A entered a teacher education program. Once they realised that they were required to teach mathematics the poor mathematical identity was addressed. The authentic use of mathematics for 'real-life' calculations had clearly been a part of the reconstruction of Principal A's mathematical identity:

*It linked to what I had to do as an adult... I knew percentages as I was working out a mortgage, trying to pay bills, and it made sense. I can see now where the research came from that says you must link it to real-life experiences.*

Slightly less confidence in procedural matters was given, with a 'mildly disagree' provided for three positive value indicators concerning mathematical activity. The main anxiety related to calculating the school budget. In statement 12, Principal A showed little need to be recognised by others as having a higher than average level of ability in mathematics. In contrast, they indicated a positive response towards mathematics from an 'observer's' point of view. For example, 'strongly agree' was given to 'solving maths problems is interesting to me' (15) but a less strong response ('mildly agree') was given to 'I am interested in doing maths problems' (17).

90% of teacher respondents showed that they held positive feelings towards mathematics for 11 of the statements but mathematics anxiety in earlier life stages had been present for some participants, as one teacher explained:

*I hated maths at school. I never seemed to get it. I had an excellent lecturer at University for teacher training who explained things in ways that I'd never thought of before. I started to enjoy maths. The PD we receive at this school has built on that and I feel that I am getting better and better at teaching it.*

Another teacher stated:

*When I went into teachers' college I was actually frightened at the thought of learning maths well enough to teach it. When I started training the lecturers taught it in a different way to how it was at school. I enjoyed it! Coming here and getting the training has only made me more enthusiastic for maths.*

Figure 4.3 shows the teachers' responses to indicators of negative feelings towards mathematics. Figure 4.4 (overleaf) shows responses to the indicators of positive feelings for mathematics. The sequence of indicators were mixed in the questionnaire but the table and figures have been sorted. If a person has little value for mathematics, or has mathematics anxiety, the columns should be hot coloured throughout Figure 4.3 and cold coloured for figure 4.4.



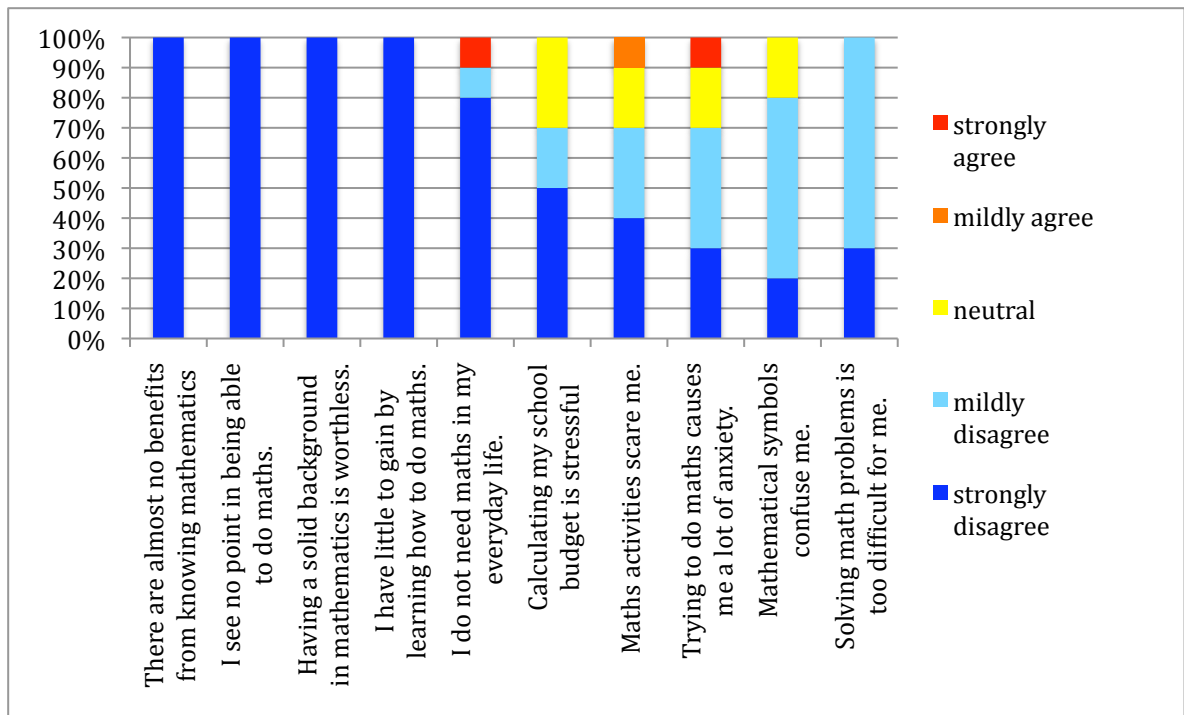


Figure 4.3: Responses to low value indicators of MVI.

In Figure 4.3 the data shows that, for seven of the ten MVI statements, 100% of respondents showed that they held mathematics to be of high value. Of the remaining three indicators, 90% showed this.

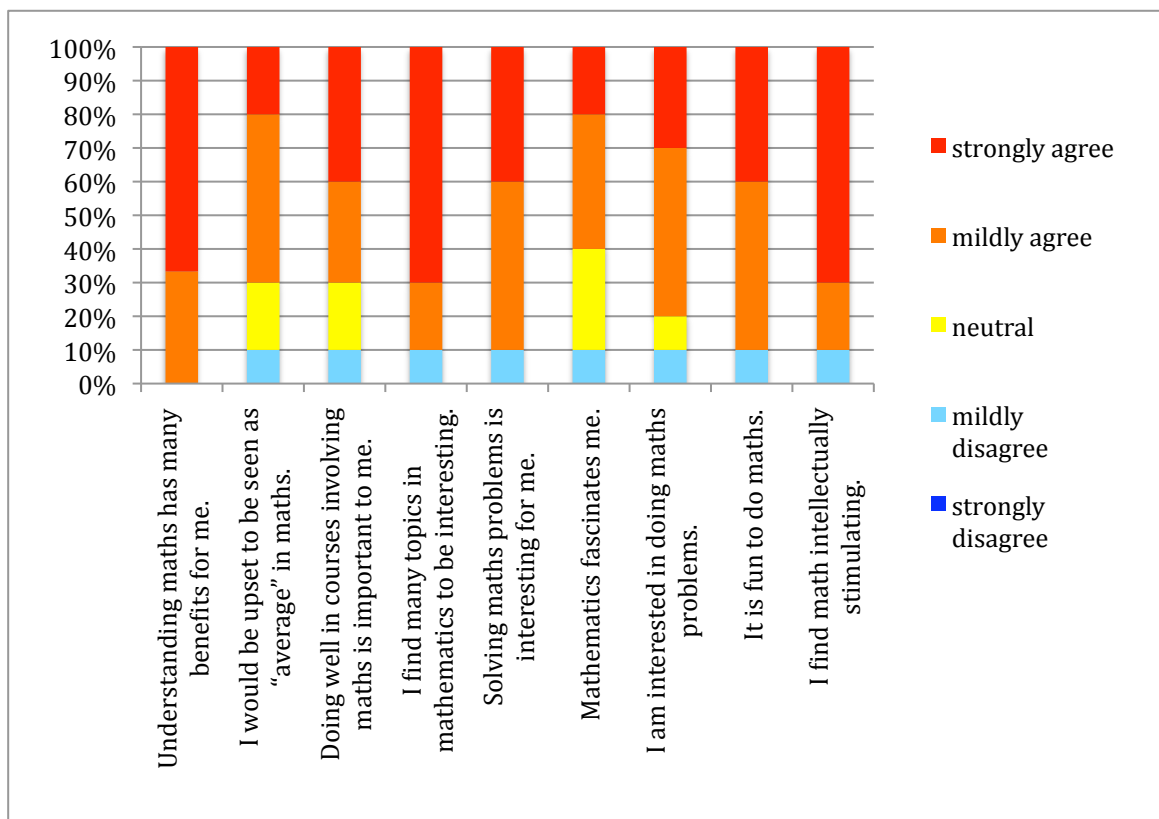


Figure 4.4: Responses to high value indicators of MVI

Figure 4.4 provides evidence that 100% of the teachers held positive feelings towards mathematics in answering question 11, 'understanding maths has many benefits for me'. 90% showed positive feelings towards mathematics for the remaining eight indicators with the remaining 10% displaying negative feelings towards mathematics.

This section was designed to relate to the mathematical identity of the teachers and Principal as a prelude to whether participation in professional development reflects a positive mathematical identity (voluntarily undertaken and a 'want' to learn), prior professional development (imposed learning) and responsibility (need to learn).

#### **4.4 Professional development**

##### ***4.4.1 Introduction***

The following section provides data related to the Principal and teachers' participation in professional development, types of general professional development activities undertaken and, more specifically, the mathematics professional development participated in or led.

##### ***4.4.2 Participation in professional development***

In School A the focus was firmly placed on mathematics and literacy. Principal A justified this focus stating that they were key curricula areas:

*We look at Literacy and Numeracy first because, as a primary school, those are the major areas that we have got to get those children up to speed.*

As shown in figure 4.5, School A teachers verified the Principal's statement, designating mathematics and literacy as the most common curricula in which they had undertaken professional development in the prior three years.

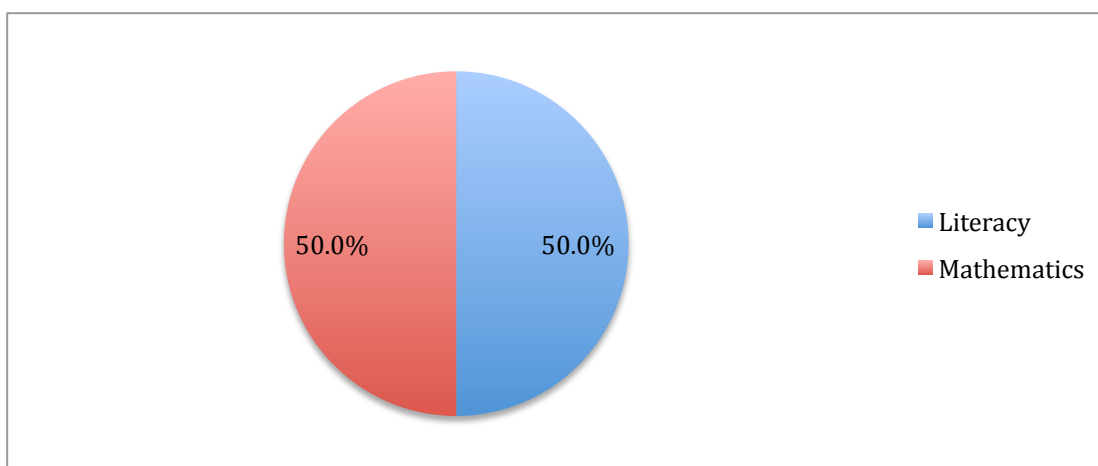


Figure 4.5: The most common curriculum area for professional development in the last three years.

At interview, Principal A stated how professional development needs were identified:

*As part of planning for the next year, I ask teachers where and at what level they would like to teach, and what professional development they think they would need and what would they see as the focus of the school. So I've got their input into what they see as things we need to improve on. I've got my, and the senior management team's, observations. We have also got whatever is coming into play from an educational perspective. If your data is showing that you have got a weakness and the children are not successful... you need to perhaps look at the staff and (ask) do they need PD.*

Evidence is provided in this statement that Principal A consulted with and considered the needs of individual teachers. Likewise their pedagogical practices were observed and weaknesses identified, student achievement data was noted, and governmental initiatives were taken into account before goals for professional development were established. The teachers concurred with Principal A's statement about how school-wide professional development goals were established and at the same time noted that their personalised needs for professional development were also met:

*I feel fully involved in what professional development I'm going to get throughout the year. I love knowing that maths or literacy professional*

*development is ongoing, because these things are important to students to understand anything else. Even then, if I feel I need PD in a different area I can approach my team leader or (Principal A), present my case and get the PD I need. I've never been refused yet.*

#### **4.4.3 Participation in various types of professional development related to mathematics**

In the questionnaire the types of professional development opportunities related to mathematics education that the teachers had participated in, over the preceding three years, were explored. A range of choices of various types of professional development is shown in Figure 4.6. The percentage of School A teachers who had undertaken the different types of mathematics education professional development is also illustrated.

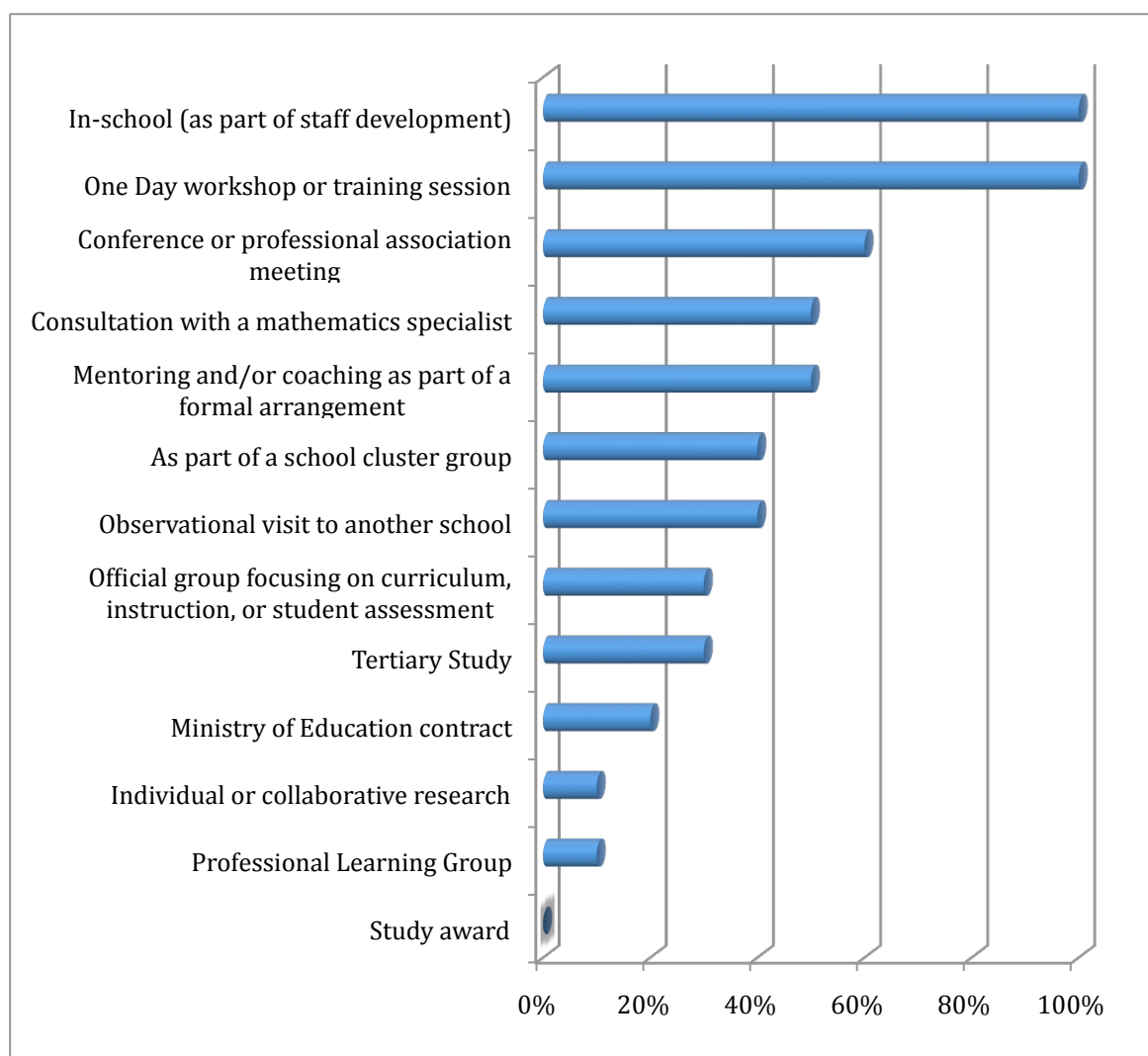


Figure 4.6: Types of professional development undertaken in mathematical pedagogy

Although a wide range of options was used, the school focus on mathematics (often with external facilitators) is shown in the responses for specific types of professional development. For instance, 100% of teacher respondents had undertaken mathematical professional development activities in school (as part of staff development), and 100% had one-day, mathematics based, workshops or professional development sessions. 60% attended a conference or professional association meeting and 50% had been in consultation with a mathematics specialist and received mentoring and/or coaching as part of a formal arrangement.

Principal A had also participated in these professional development opportunities and had attended a mathematical conference.

#### **4.4.4 Inclusion of development goals in appraisals**

School A's Boards of Trustees placed an emphasis on the professional development of their Principal and professional development goals were a part of the Principal's annual appraisal. Professional development for mathematics was not specifically included but during interview the Principal noted the need for its inclusion, when asked if mathematics should be part of a principal's appraisal:

*It could be. It depends what your goals are for your school.... I think it comes in with the pedagogy part of your appraisal but is not the only part, if you see what I mean. It does have a place there. I think literacy and numeracy must have a place there because they are so important in those early years.*

90% of the teachers were part of an annual appraisal system. 100% of the respondents who were part of the appraisal system had professional development goals as a part of their appraisal whilst 78.0% of those included mathematics as part of their appraisal.

#### 4.4.5 Content of mathematical professional development

Figure 4.7 summarises the results of answers to a question that explored what the Principal and teachers had learned about mathematical pedagogy and content through their involvement in professional development activities. The options for answers were: Not at all; some learning as part of general PD; small extent; moderate extent, and; large extent.

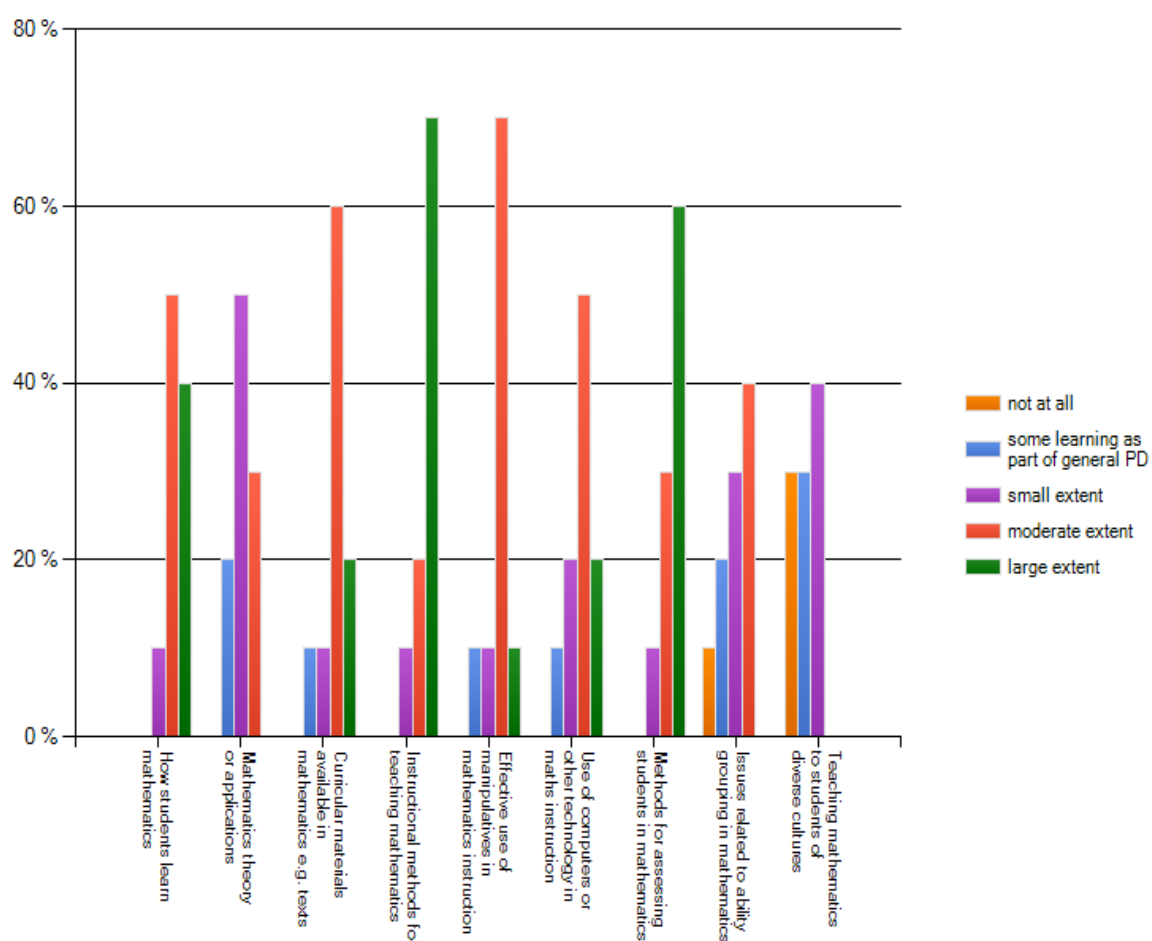


Figure 4.7: To what extent respondents learned about mathematical topics through professional development

Only two mathematical content areas were absent from the professional development (shown as orange columns in Figure 4.7). 10% of respondents said they had not received professional development in issues relating to ability grouping in mathematics, while 30% said they had not received professional development in teaching mathematics to students of diverse

cultures. The highest response, signified as covered to a 'large extent' (shown as green columns), was for instructional methods for teaching mathematics, at 70%, and methods for assessing students in mathematics, at 60%.

#### **4.5 The effectiveness of professional development in mathematics**

This section sought to explore the perceptions of the Principal and teachers of School A about the effectiveness of particular types of professional development and to establish any alignment with researched best practice in professional development types and effectiveness.

##### ***4.5.1 Perceptions of the effectiveness of professional development in mathematics***

When addressing the impact of professional development in mathematics on the individual teachers, Principal A said it had had a large positive impact on themselves and on the staff but only a moderate positive impact on the students. 80.0% of the teachers believed that the mathematics professional development they participated in had had a large positive impact on them; the remaining 20.0% responded that a moderate positive impact had been gained. With regards to student achievement, 50% stated that their professional development had a large positive impact, 40.0% believed that it had a moderate positive impact and 10.0% thought it had only had a small positive impact on student achievement. The need for time and reflection on pedagogical practice and change was noted when one teacher recognised the large personal positive impact of it on herself but its moderate impact on her students:

*The PD sometimes takes time to become embedded in your practice. You have an 'aha' moment but it'll take time to put that in your program in a way that suits your class.*

#### **4.5.2 Perceptions of the most effective types of professional development in mathematics**

The Principal and teachers were asked to select from a list of options describing a range of professional development methods, and rate them according to their perception of what is most effective. They were able to select more than one option.

Principal A stated that a one day workshop or training session in-school as part of staff development, and professional learning groups were the most effective methods for his or her own professional development. The Principal described a range of professional development methods as most effective for staff. These included; Conference or professional association meeting; mentoring and/or coaching as part of a formal arrangement; as part of a school cluster group, and; in school (as part of staff development). In sharp contrast to Principal A's beliefs on effective professional development, the teacher responses were more varied, as shown in Figure 4.8.

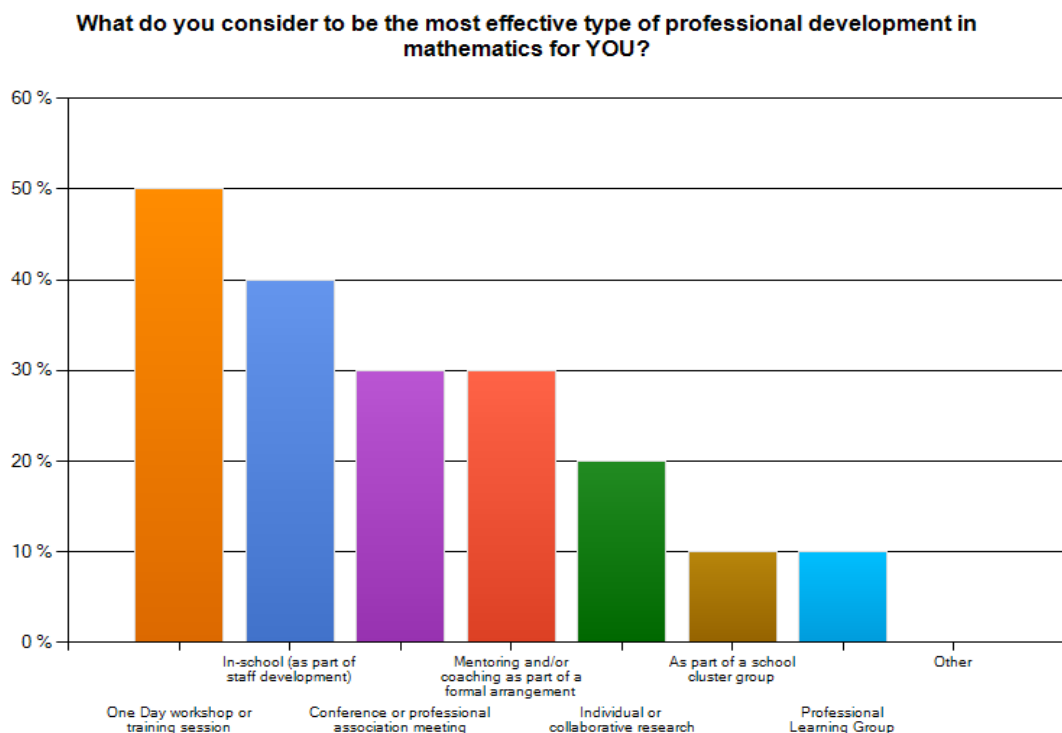


Figure 4.8: Perception of effectiveness of professional development



50% of the teachers believed that a one-day workshop or training session was a most effective method but 40% also supported on-going, in-school professional development. 30% selected mentoring and/or coaching as part of a formal agreement for effective professional development. 30% supported a conference or professional association meeting, 20% individual research, and 10% for professional learning group, or being part of a school cluster group.

#### **4.6 Impediments to accessing professional development in maths**

In the survey Principal A was asked to identify any impediments they saw which impeded access to professional development in mathematics for themselves or their staff. A comments box was offered rather than multiple-choice selection so that specific context barriers could be identified. Principal A commented:

*Costs can be prohibitive, (it) needs careful budgeting as most staff want to attend PD. This is an area they feel important to keep up with latest methods, resources and they are very positive about Mathematics in the school.*

In interview Principal A reiterated the prohibitive costs of professional development and expanded to explain conflicting demands between focused professional development in mathematics and the professional development required to meet other demands such as governmental initiatives, e.g., New Zealand's National Standards.

*National Standards came in... that impacts on professional development budgets for this year and I have to go back to the board and say, "Can we increase it (the mathematics professional development budget)?" so that we can still send people to the maths day, for example, at the University of Auckland, and the Maths Association day on a Saturday every year.*

#### 4.7 Principal A's leadership of mathematics

In the survey the Principal was asked to indicate their perceptions of their leadership in mathematics. The options were: Full control; mentor; coach; delegate; distributive, and; facilitative leadership. Principal A selected the option of distributive leadership to describe their leadership. Principal A stated:

*We have a maths team of teachers led by two lead teachers, who are good practitioners and have good pedagogical knowledge. I am involved in the team and decision-making and in setting a budget that will allow for the gains made to be sustained.*

In contrast, only 10% of the teachers thought that distributive leadership was the Principal's preferred style. 10% thought it was that of a coach and 20% believed the Principal delegated mathematics leadership. One teacher clarified their position, saying:

*We have a lead teacher in the school who is responsible for leadership in maths and staff PD.*

60% thought the Principal facilitated mathematics leadership. One of the teachers with this point of view noted that the Principal was:

*very happy to support new ideas, promote professional development, try out new systems, encourages and trusts lead teachers, help to increase the dialogue of mathematics within the school.*

Another teacher stated:

*I know the Principal is very maths oriented. Coverage and discussion is of importance.*

In interview, the teachers corroborated Principal A's perception of shared

leadership in mathematics or one that was moving towards parallel leadership, with a teacher (not a curriculum team member) commenting that the Principal:

*“is always there, always involved, and always supportive. There is no obvious micromanagement but (his or her) influence is obvious and welcomed. It keeps us moving forward.”*

This is in contrast to the 10% survey response that the Principal displayed this style of leadership. Principal A described complete involvement in senior management level strategies for mathematics development and resource allocation but also stated that they were active within professional development sessions as well:

*We have a numeracy team and every area of the school is represented on that team, so a teacher from each year level must be on numeracy. That team meets once a term, or more if they want to... We also have at least one staff meeting per term in maths and it usually targets an area that has come through that team meeting. I go to the meetings for literacy and numeracy. I go to both of those because part of being a principal is that you do lead those areas.*

Evidence is provided in this statement that Principal A distributed leadership for mathematics to the mathematics curriculum team. The make up of the curriculum team is such that all year levels are represented and are recipients of the professional development offered. There was a formal means for passing on improved learning and pedagogical practices to the rest of the staff. It is also evident that Principal A not only promotes professional development in mathematics but also participates in the professional development. They assumed an interactive role of leadership reciprocity (Anderson, 2005) through attendance at the meetings and direct involvement in the professional development.

*But to say you lead them through being in the classroom is not practical.*

From this statement it becomes evident that and Principal A leads the whole-school strategy and professional development provision in mathematics whilst being cognisant of the complexity of the role and admitting that constant classroom presence is not possible for a Principal.

*You also have to go into your staff meetings... I would never think of not going to staff meetings. I ask the questions that everyone else is thinking about (laughs)... I am very much a learner and the whole ethos of the staff is that we are all learning. We are always learning and if we don't change we won't go forward.*

This statement demonstrates that Principal A ensures that professional development is of the highest priority and part of the culture of School A. Their attendance demonstrated that professional development opportunities were important events and took the role of lead learner. Principal A merged internal professional development with external opportunities, including the provision of externally facilitated 'lead teacher workshops' twice each term, delivered by a University based consultancy. Time and monetary resources were provided to allow attendance at these workshops and the Principal managed the resources.

A mathematics curriculum team member explained that the team and other individual members of staff with particular professional development needs attended externally facilitated workshops. Curriculum team meetings were also held at the school and these focused on how best to implement new learning throughout the school and recommend what resources were required. The Principal attended these meetings. Staff who did not have identified mathematical professional development needs received information through regular staff meetings where learning opportunities were scaffolded down from the curriculum team.

#### 4.7.1 Reinforcement of mathematics professional development

Professional development has no value unless it leads to a change in classroom practice. This requires that an educational leader implement procedures to reinforce the learning from the professional development. In the Principal survey a question explored what reinforcement activities were used to ensure that professional development resulted in improvements in pedagogical practice. Principal A recorded: “Planned staff meetings regularly throughout the year. Encourage teachers to attend maths seminars, Primary Mathematics Association days, have lead teachers model in class for them.”

The teachers were asked to respond to how they viewed their Principal’s effectiveness in promoting on-going learning from professional development. Figure 4.9 graphically shows the responses.

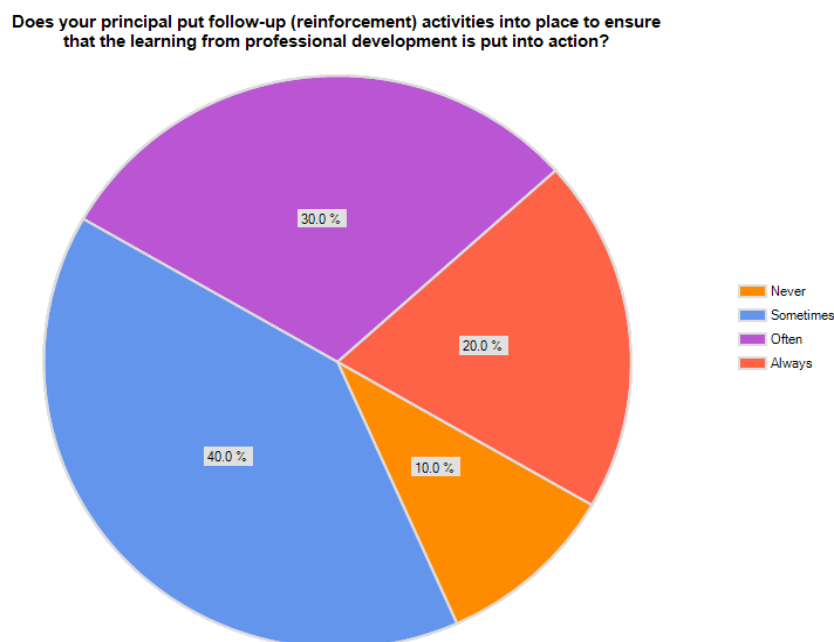


Figure 4.9: Perception of frequency of reinforcement activities

90% of the teachers recognized some level of reinforcement activity, with 20% perceiving that the Principal always put reinforcement activities in place, 30% perceiving the Principal often put reinforcement in place, and 40% recognizing such activities being in place but less frequently.

#### **4.7.2 Participation in discussions with staff about mathematical pedagogy**

The survey investigated how often the principal discussed mathematics with the staff. Principal A estimated discussions took place monthly. 20% of the teachers agreed with the Principal's assessment whilst 40% estimated that the Principal participated in discussions related to mathematics pedagogy once a term (10 weeks in New Zealand). 40% perceived that the Principal 'seldom' participated in discussions about pedagogy in mathematics. That Principal A participates in numeracy team meetings and every staff meeting, where mathematics is discussed, seems to contradict the 'seldom' rating. The content of the discussions varied although a key focus was student achievement. Principal A explained:

*Sometimes it can be the resources they need. Sometimes it's PD that they need. Sometimes it can be data. I will collect the data and then feedback to them what my perception of the data is showing and give it to them so they can take that away. They are interested to know where we are sitting in comparison to nationally, so the staff has those kinds of conversations too.*

#### **4.8 Teacher perceptions of the Principal's promotion of, and participation in, professional development in mathematics**

The data from the surveys and interview provided evidence that Principal A was a consistent participant in mathematical professional development through personal attendance at professional development activities, working alongside the mathematics curriculum team and in staff meetings where mathematics professional development was provided. Teachers were questioned to identify whether their perceptions matched the evidence. Of School A's teacher respondents, 50% thought the Principal's participation in professional development in mathematics was consistent, defined as more than twice a year. 30% believed the Principal's participation to be frequent, defined in the survey as twice a year. 10% perceived the Principal's

participation to be approximately once each year and a further 10% thought less than once each year.

The teachers were asked how well they believed the Principal promoted teacher access to mathematics professional development. 90% of School A believed that Principal A promoted their access to mathematics professional development well or better, with 40% describing the Principal's promotion of as done 'extremely well' and 50% rating it as 'well'. 10% answered that they believed that their Principal promoted only moderate access. The teachers were then asked to rate the amount of professional development in mathematics they received against perceived effectiveness for maintenance of, or improvement in, classroom practice. Figure 4.10 illustrates that 60% believed that they had enough professional development to improve their mathematics teaching for a long time (sustainable improvements). 30% stated that mathematics professional development was sufficient to improve over a short time or maintain their current practices. In the survey response there is no way to discern whether members of this group of teachers already demonstrated best practice.

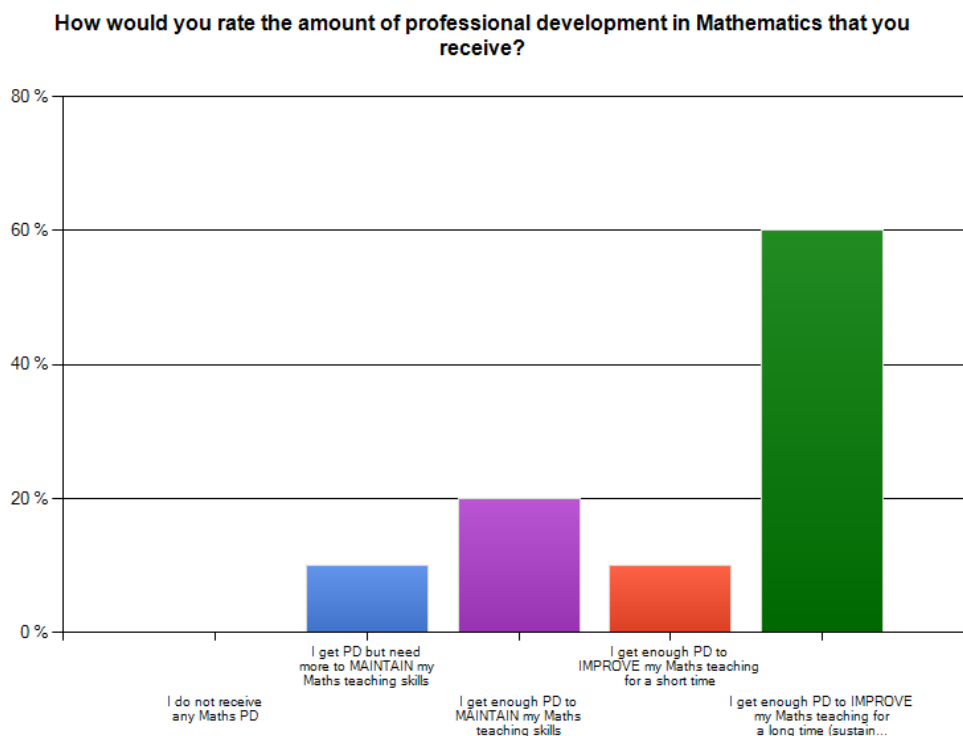


Figure 4.10: Perception of amount of mathematics professional development received to aid mathematics teaching.

#### 4.9 Teacher Perception of how well they believe the Principal leads professional development in mathematics

The final survey question explored how well the teachers believed that the Principal led professional involvement in mathematics. Figure 4.11 shows the responses.

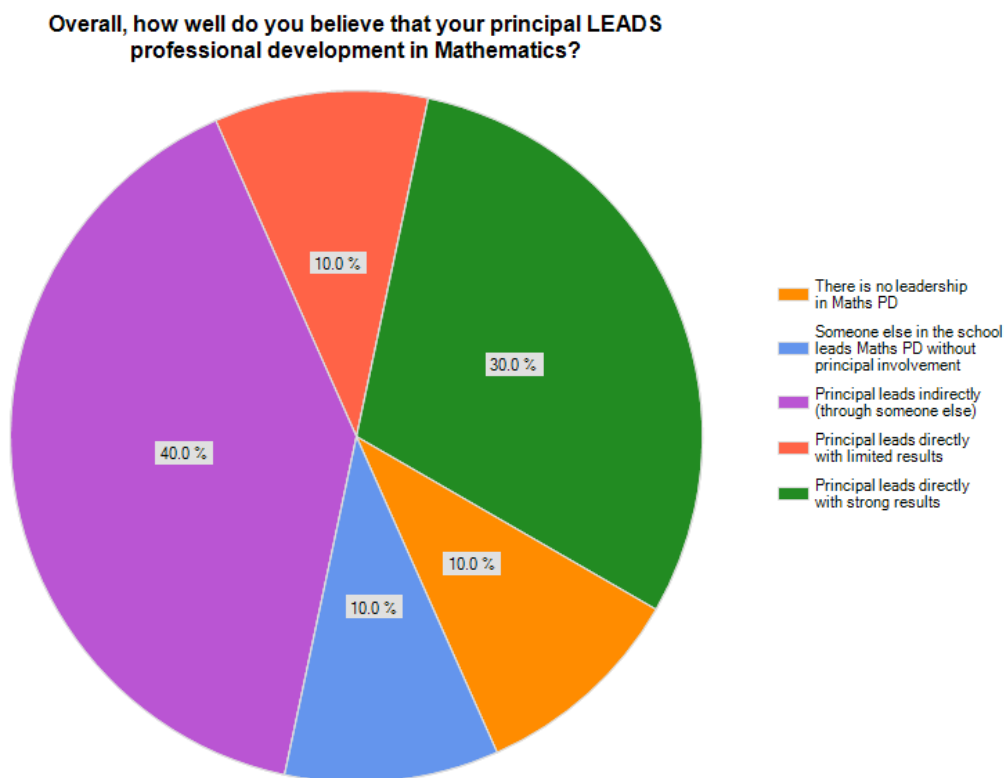


Figure 4.11: Perception of leadership of professional development in mathematics

80% of the teachers considered that the Principal led mathematical professional development. However, the perceived *levels* of leadership differed between groups of teachers as illustrated in Figure 4.11. 30% of the teachers believed that the Principal led directly with strong results. 40% stated that the Principal led indirectly through someone else (the lead teacher) and 10% believed that the Principal led directly but with limited results. These results show that 80% of the teachers viewed the Principal as providing leadership in mathematics professional development either directly or within a facilitative role.



## **CHAPTER 5: FINDINGS - SCHOOL B**

### **5.1 Introduction**

School B's Principal and teachers completed the same questionnaire as School A. Individual responses, recorded in the comment boxes, were used where needed to elaborate a viewpoint.

### **5.2 Teacher Profiles**

The teacher profiles are described in the same formation as that used in Chapter 4. The first section of the questionnaire examined age range, experience and number of years in current position. The second section concerned the mathematical qualifications held by the respondents, whether they had taken part in a professional development contract for mathematics, including the Numeracy Project, and their previous responsibility for mathematics as a department. The respondents represented approximately 60% of the total teaching staff at School B.

#### ***5.2.1 Age and experience***

The teachers' age ranges are shown in Figure 5.1. In contrast to School A, the ages of the teachers at School B were more widely spread with representatives at each of the age groups up to 65.

Similar to School A, the ages were collected to give an insight into the respondents' possible beliefs towards mathematics as influenced by the way they themselves were taught.

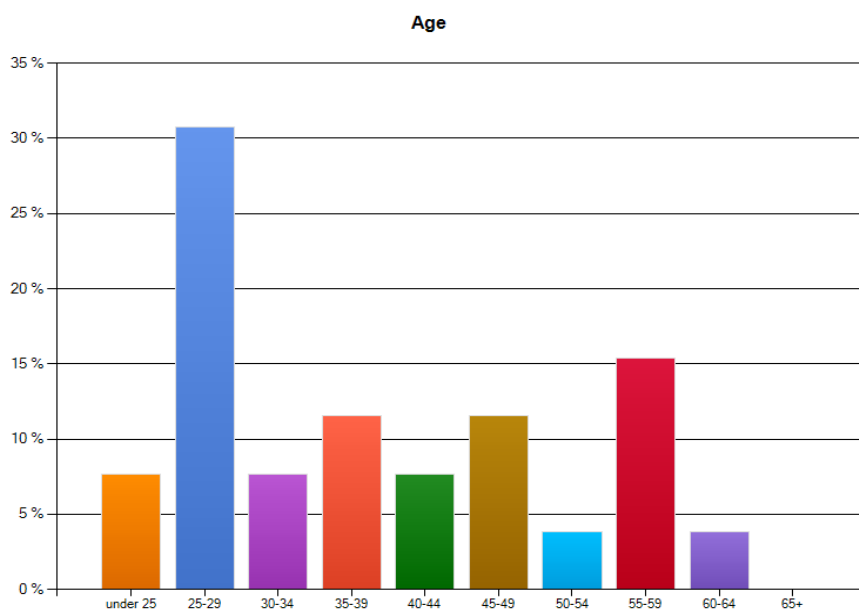


Figure 5.1: Age of Respondents

The largest percentage of teachers was in the age range of 25 to 29 with 30.8% of the teachers in this age group. Teachers under the age of 25 accounted for 7.7%. These teachers would likely have been taught mathematics at primary school under the constructivist pedagogy of the newly introduced curriculum of 1992, assuming that their teachers had received and implemented the professional development that accompanied the introduction of the new curriculum. A further 7.7% of teachers were in the 30 to 34 year old age range and would have been at the end of their primary education as the constructivist pedagogy was introduced to replace the behaviourist pedagogy of the previous curriculum. 53.8% of the teachers were 35 years or over and would have been at primary school prior to the introduction of the constructivist based curriculum in 1992.

The experience of the teachers was recorded in terms of years as a teacher, not only in their present school. 23% had 3 years or less experience, 35% had between 4 and 10 years experience, 11% had between 10 and 15 years experience and 32% had over 20 years teaching experience, with the highest in the group being 36 years. The time 'served' in their present school ranged from one to sixteen years. One of the respondents was the lead teacher of mathematics.

### **5.2.2 Mathematics qualifications, mathematical professional development and mathematics anxiety**

Principal B stated that they had formally studied Level 1 mathematics as a university undergraduate for a non-mathematical degree. They had not completed further qualifications that included mathematics or had a mathematics education component. Principal B had participated in a Ministry provided professional development contract for the New Zealand curriculum but had not taken part in professional development offered through New Zealand's Numeracy Project. The school Principal B led did not participate in the New Zealand Numeracy Project because, the Principal stated, they saw no need:

*At that time, our maths results overall were very, very good so we couldn't see the need.*

Teachers qualifications attained in mathematics varied. This is shown graphically in Figure 5.2.

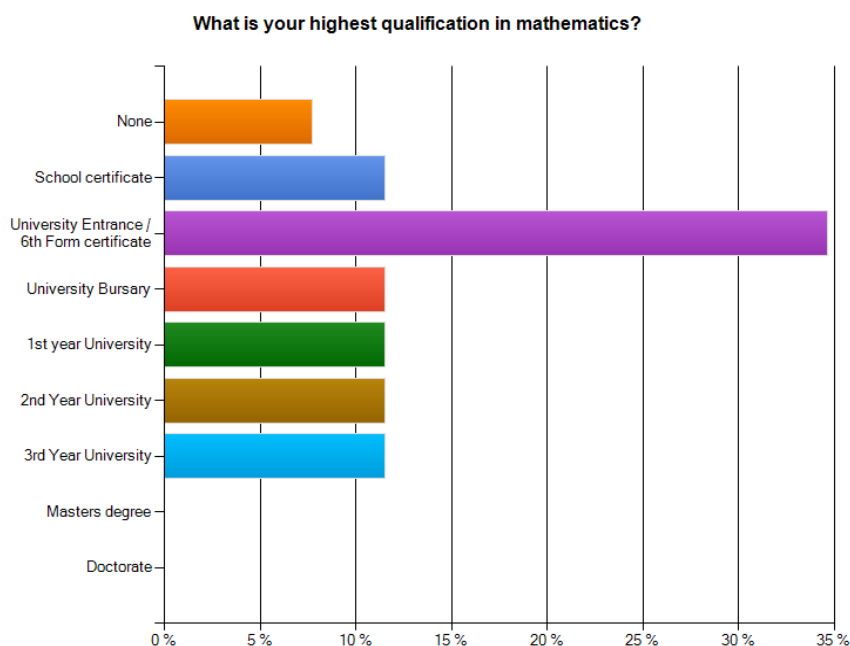


Figure 5.2: Highest qualification in mathematics.

65.4% had not studied mathematics beyond high school and 34.6% of the teachers had studied mathematics at University as part of a non-mathematics degree. Almost half (44.4%) of those teachers who did mathematics at University did so as part of teacher education programs.

Despite the teachers in School B holding higher mathematics qualifications than those held by the teachers in School A an item of discussion linked to their recognition of other teachers' lack of content knowledge:

*I think that it is interesting that, where there are kids from level 3 to level 6, there are teachers at our school who don't know higher than 3A. You know, how are we catering to those top kids when the teachers don't know it?"*

19.2% of School B's teachers had participated in a Ministry contract for mathematics in the New Zealand curriculum. 50% of the teachers had participated in the professional development within the Numeracy Project.

### **5.3 Assessing mathematical identity**

Using the Mathematics Value Inventory (MVI) as a basis (Luttrell, et al., 2010), questions were posed about Principal and teacher attitudes towards mathematics.

Respondents rated their feelings on a five-point scale, ranging from strongly disagree to strongly agree. Table 5.1 shows collated responses. A coloured letter 'P' indicates the Principal's answers. Agreement with statements 1 to 10 (shaded blue) indicates negative feelings towards mathematics and agreement with statements 11 to 19 indicates positive feelings towards mathematics for the participant.

		Strongly disagree	Mildly disagree	Neutral	Mildly agree	Strongly agree
1	There are almost no benefits from knowing mathematics	92% P	0.0%	0.0%	0.0%	8.0%
2	I see no point in being able to do maths.	92% P	4.0%	0.0%	0.0%	4.0%
3	Having a solid background in mathematics is worthless	84% P	8.0%	0.0%	0.0%	4.0%
4	I have little to gain by learning how to do maths	88% P	8.0%	0.0%	0.0%	4.0%
5	I do not need maths in my everyday life	76.0% P	12.0%	4.0%	8.0%	12.5%
6	Calculating my school budget is stressful	40.0% P	12.0%	40.0%	4.0%	0.0%
7	Maths activities scare me	52.0%	20.0% P	12.0%	12.0%	4.0%
8	Trying to do maths causes me a lot of anxiety.	44.0% P	28.0%	12.0%	12.0%	4.0%
9	Mathematical symbols confuse me.	48.0% P	24.0%	12.0%	8.0%	8.0%
10	Solving math problems is too difficult for me.	36.0% P	40.0%	4.0%	16.0%	4.0%
11	Understanding maths has many benefits for me.	0.0%	8.0%	4.0%	28.0%	60.0% P
12	I would be upset to be seen as “average” in maths	12.0%	4.0%	20.0%	40.0%	24.0% P
13	Doing well in courses involving maths is important to me	4.0%	4.0%	32.0%	28.0% P	32.0%
14	I find many topics in maths to be interesting	4.0%	4.0%	12.0%	36.0%	44.0% P
15	Solving maths problems is interesting for me.	0.0%	24.0%	4.0%	32.0%	40.0% P
16	Mathematics fascinates me.	12.0%	16.0%	12.0%	36.0%	24.0% P
17	I am interested in doing maths problems.	8.0%	16.0%	12.0%	40.0% P	24.0%
18	It is fun to do maths	4.0%	4.0%	20.0%	32.0% P	40.0%
19	I find maths intellectually stimulating	0.0%	12.0%	12.0%	32.0% P	44.0%

TABLE 5.1: SCHOOL B: MATHEMATICS VALUE INVENTORY SCALE RESPONSES

In the statements of negative MVI indicators (statements 1 to 10) Principal B showed that they held mathematics to have a high value. Their responses indicated that they recognised the importance of mathematics as a subject area and as a life skill. However, by answering ‘mildly disagree’ when responding to, ‘Maths activities scare me’. Principal B confirmed that

mathematics in their life had a utilitarian purpose rather than something they chose as a leisure activity. This is further confirmed when considering the positive MVI indicators (statements 11 to 19). Although Principal B indicates the need to be recognised by others as having a higher than average level of ability in mathematics (statement 12), they indicate through their responses that they would not purposefully engage in mathematics activities (for example, using ‘mildly agree’ for ‘it is fun to do maths’). Otherwise, they indicated that they held positive feelings towards mathematics and no anxiety towards the subject.

Principal B was questioned further in interview about how they saw their relationship with mathematics:

*I found maths a challenging subject. I always passed but I think it was more through good luck than a passion for it.*

The response confirms that while Principal B was confident to use mathematics in their daily activity it was a field they had no enjoyment exploring.

In Chapter 4 I illustrated the teachers’ responses to the MVI indicators in chart format (see page 61). These charts are used again in this chapter to show the teachers’ responses to the MVI indicators. Figure 5.3 (overleaf) shows the teachers’ responses to the negative MVI statements whereby agreement indicates negative feelings towards mathematics, in a chart format. Figure 5.4 shows teachers’ responses to the positive MVI statements. As in Chapter 4 the answers are coloured. Although the sequence of MVI indicators were mixed in the questionnaire, the table and figures have been sorted. If a person has negative feelings towards mathematics, or has mathematics anxiety, the columns should be hot coloured throughout Figure 5.3 and cold coloured for figure 5.4. The treatment of ‘neutral’ as a response is problematic in that it does not show a move towards low value perceptions of mathematics or mathematical

anxiety but it does infer that the respondent so answering is not confident to show a strong mathematical identity either. Apathy for the area responded to neutrally may be deduced as easily as a lack of decision. The reader, therefore, may interpret the yellow bands indicating neutral in their own frame of reference.

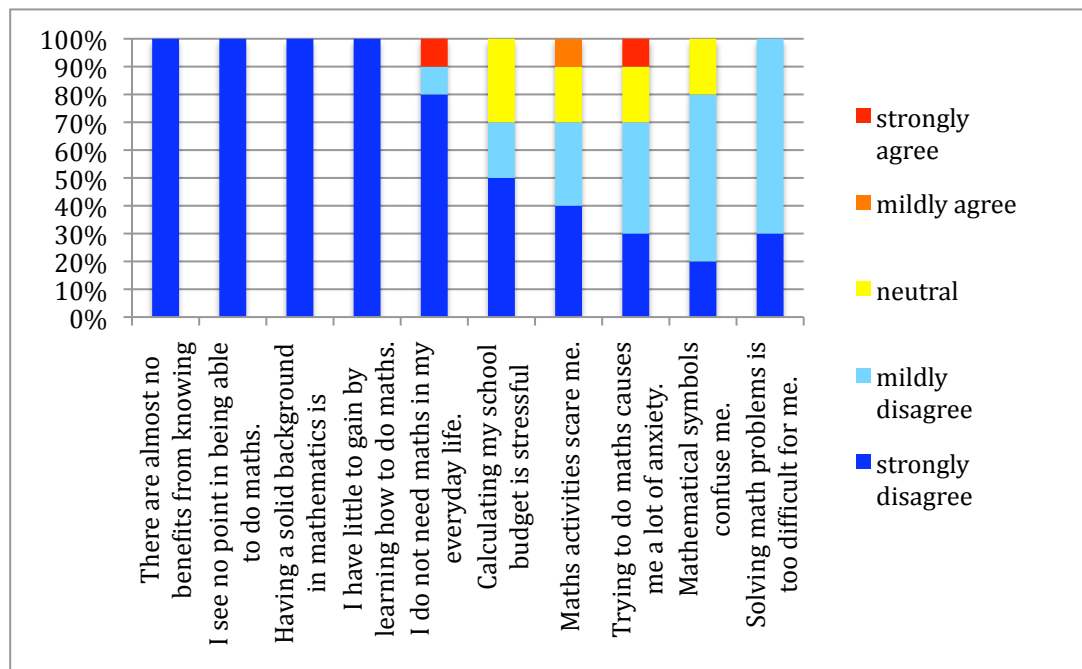


Figure 5.3: Responses to low value indicators of MVI.

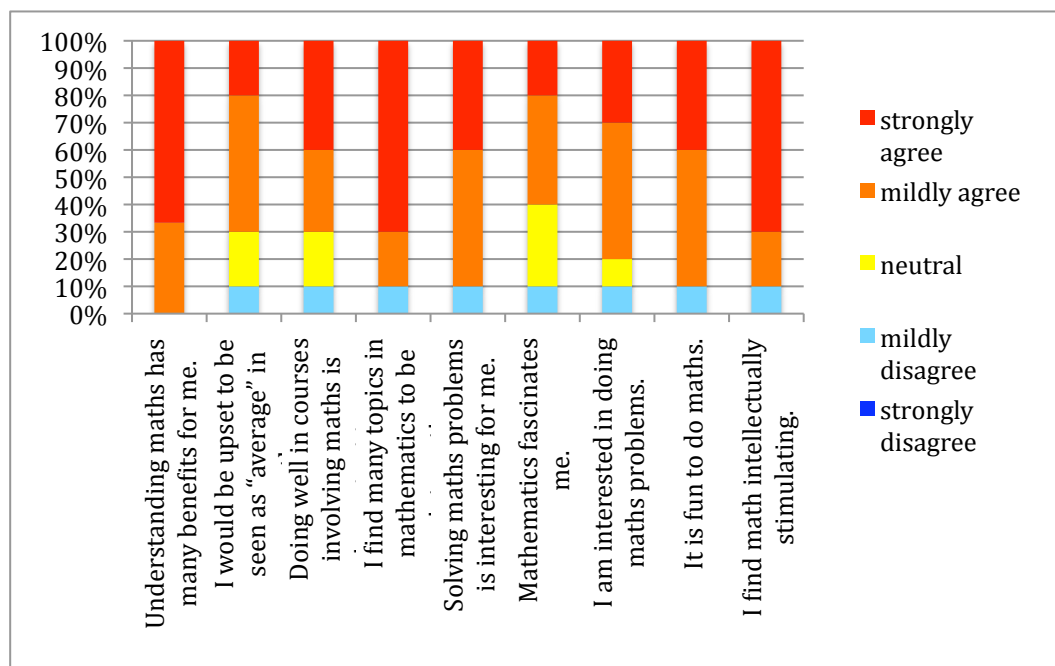


Figure 5.4: Responses to high value indicators of MVI.

Every section explored by the MVI test showed that some teachers in School B exhibited negative feelings towards mathematics or mathematics anxiety for that section, ranging from 4% concerning the usefulness of mathematics to 38% for personal interest in mathematics. Some teachers were in the process of repairing a poor mathematical identity from their time as a school student. One teacher said, in interview:

*I did not get maths until I was older, when I started teaching, I was about 24, and I did not think I was very good. I basically did maths (in a combined) 6<sup>th</sup> and 7<sup>th</sup> form (class) and the 6<sup>th</sup> formers were extension students... Because the 6<sup>th</sup> formers were doing the 7<sup>th</sup> form things really well, we were like the dumb 7<sup>th</sup> formers... When I started teaching maths I realised I was quite good.*

Another teacher said:

*I can understand what (T3) is talking about... I do not think I am a natural mathematician. At high school, it was never a strength... and I think because I knew that, when I went teaching it was probably the thing I least enjoyed teaching.*

Between 4% and 28% of teacher responses showed negative feelings and an explicit lack of value for mathematics or mathematics anxiety for all of the 19 questions. If neutral is considered as a lack of positivity to mathematics this range is increased to 4% to 44%.

## **5.4 Professional development**

### **5.4.1 Introduction**

The survey used in School A was also employed in School B to examine what types of professional development the teachers had participated in or led and, more specifically, what types of professional development in mathematics the teachers had participated in or led.



#### 5.4.2 Participation in professional development

Principal B described how professional development priorities were identified for School B:

*I identify from analysing the data and creating a list of no more than five priorities for development in terms of learning needs. Now that might be across the curriculum, it might be within the context of the curriculum.*

Principal B stated that a co-ordinated approach to selecting goals across all areas of the curricular for professional development was used. However, this is contrasted by the School B teachers' identification of the curriculum areas in which they had received professional development in the past three years. In Figure 5.5, 32% of the teachers from School B selected literacy as the most common curriculum area in which they had undertaken professional development (although they could enter multiple curricula in the survey text boxes they excluded any other curricular). The teachers' second most common selection was ICT and inquiry professional development. English as a second or other language (ESOL) was the third selection. Mathematics and Music were selected by 8% of the teachers and Science and Physical education were selected by 4% each.

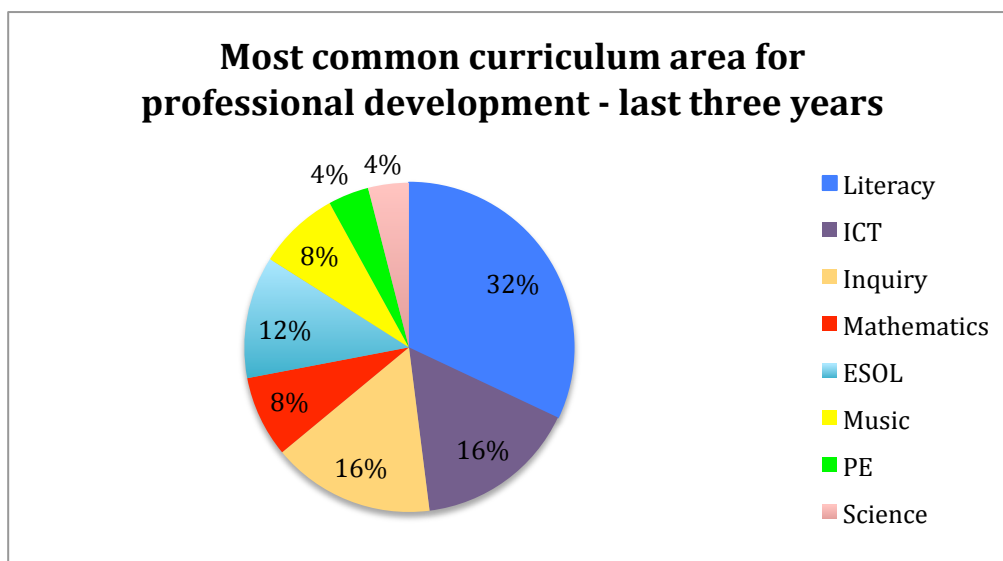


Figure 5.5: Most common curriculum area for professional development

Teachers from School B stated that there were too many initiatives the school participated in. This resulted in a lack of focus for professional development programmes. They questioned the lack of time to reflect and gather evidence of the effect or sustainability of the professional development initiatives:

*Rather than “We have got to do this, we have got to do that, let's move onto this next thing”, we've got to go, “We have actually invested quite a lot of time and energy into this, perhaps we should see if this is working. Maybe we should keep going.” You know? Rather than, “Oh, this is this new thing, let's do that.*

They voiced concern at the apparent lack of School Bs' strategic goals or links to best classroom practice:

*In terms of sustaining it, we need to establish some clear goals of what it is we were trying to achieve... we should be setting some strategic direction and goals. You tie in the professional development to that... give people the opportunity to go and look at best practice in classrooms. Also set up some observations because, unless you actually teaching with someone watching how are we going to monitor any pedagogical improvement?”*

#### **5.4.3 Participation in various types of professional development related to mathematics**

A question in the questionnaire explored the types of professional development opportunities the teachers had participated in over the preceding three years specifically related to mathematics education. The types of professional development which linked to developing mathematical pedagogy or knowledge and the percentage of teacher respondents at School B that had undertaken those types of mathematics education professional development is illustrated in Figure 5.6.

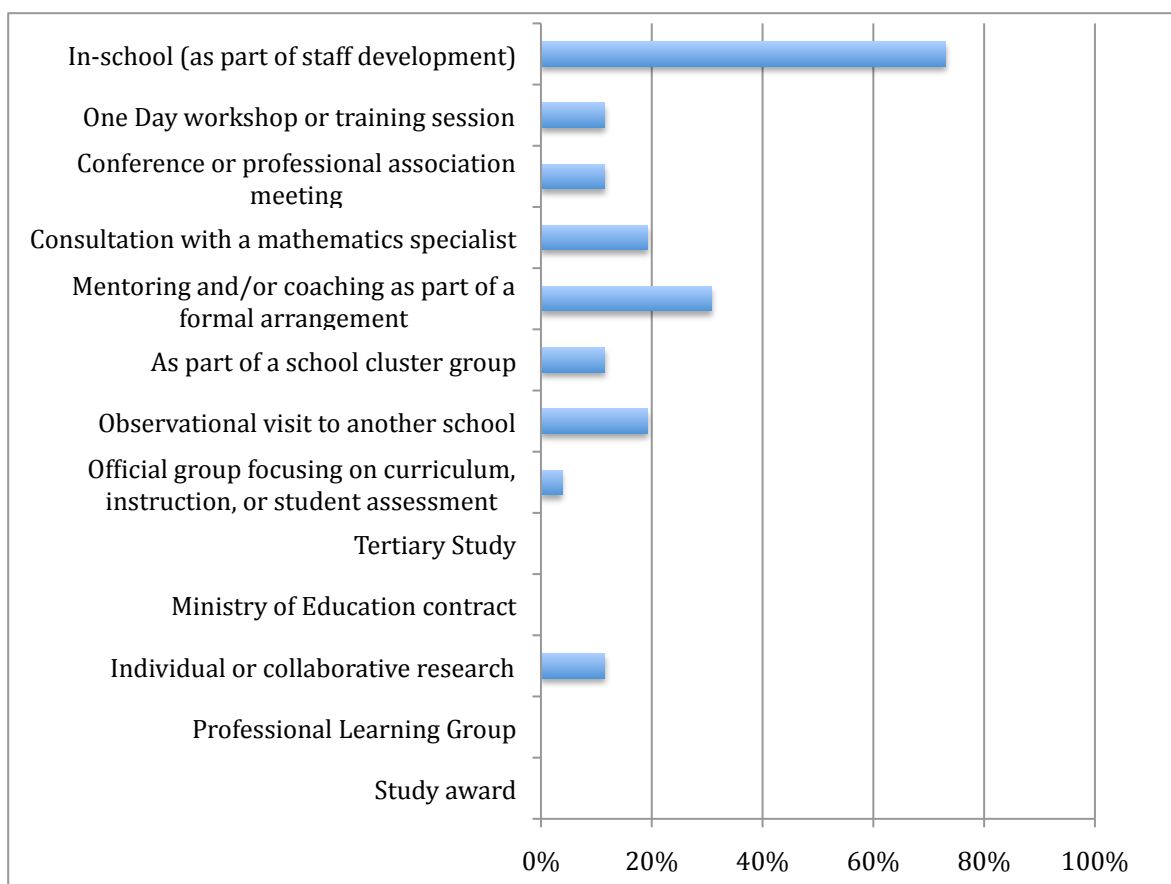


Figure 5.6: Types of professional development undertaken

Similar to School A, a wide range of options was used for professional development in mathematics. 73% of teachers had undertaken mathematical professional development in school (as part of staff development). However, each of the responses indicated they had attended only one workshop and that appeared to be the same workshop for all. 31% had received mentoring and/or coaching as part of a formal arrangement. 19% had been in consultation with a mathematics specialist and the same people reported that they had done an observational visit to another school. It was unclear whether the consultant was involved in the observation or not.

School B's teachers described the professional development in mathematics offered in the school as inadequate to meet their needs or the needs of other staff members. They stated that professional development in mathematics had not been a school goal in the previous three years nor did it appear to be considered. Different members of the focus group stated their view and this appeared to be unanimously held:

*I can think of one instance, in three years, where I found it (mathematics professional development) quite beneficial. I don't feel there is any profiling for maths in the school. I don't think there's any opportunity.*

A second teacher agreed, added:

*I would agree. I don't think we have done maths PD. I can't even remember doing maths PD. I don't think it has got a big profile. I don't think we are helping people that don't have strength in maths enough.*

The Principal outlined how they had participated in mathematics education professional development when they attended a conference, a one-day workshop with a professional learning group, and when they had consulted with an external facilitator. After further probing at interview Principal B referred to the need for school leaders to develop and recognise best practice in mathematics pedagogy as a result of changes over the previous 20 years, Principal B acknowledged that Principals as school leaders:

*...need training themselves. They need to have curriculum training. They need to engage in learning with the person to whom it is delegated so that you have a shared understanding in the leadership team.*

#### **5.4.4 Inclusion of development goals in appraisals**

Principal B and 69.2% of the teachers were part of an annual appraisal system. All teachers who had appraisals developed professional development goals as a part of the process. The Principal was not required by the Board of Trustees to develop personal professional development goals and reported that there were none. 27.7% of the School B teachers who had professional development goals included mathematics as part of these within their appraisal system. Principal B justified why appraisal goals related to pedagogical practices or knowledge (and more specifically in mathematics) were not required for Principals in describing their leadership role:

*It depends whether you are talking about the leadership of the skill development or the leadership of the content development. Because a principal doesn't need to know the content to be able to lead curriculum... So for me, it is about the curriculum model, the understanding of the curriculum delivery, what needs to happen around curriculum delivery... and to cascade that development so that there is a consistency in understanding throughout the school.*

#### **5.4.5 Content of mathematical professional development**

In a previous section I described how Principal B stated that they identified professional development needs by analyzing data and creating a list of five priorities for the school. In later questions related to the content of professional development Principal B described a different approach to how resources of people, time, and money were allocated, particularly in mathematics:

*It is dependent upon how we analyse the needs. So, in this case, it is across school. ... in that case, it was that everybody needs this. We all need to be on the same page, which is unusual because most of the time, at this school, we target teachers as individuals..."*

Principal B's statement has recognised the central position mathematics holds in all schools and therefore the problem in taking an individualised approach to teacher professional needs in a core curriculum area.

Acknowledging that mathematics holds a central position in schools, the next section explored exactly what areas teachers learnt about in the professional development they did receive in mathematics. Figure 5.7 shows the extent the teachers had learned about *mathematical* pedagogy through professional development. The options for answers were: Not at all; some learning as part of general PD; small, moderate, and large extent. Principal B had covered all options to a 'moderate extent' except for 'effective use of

manipulatives in mathematics instruction', in which the response was 'not at all'.

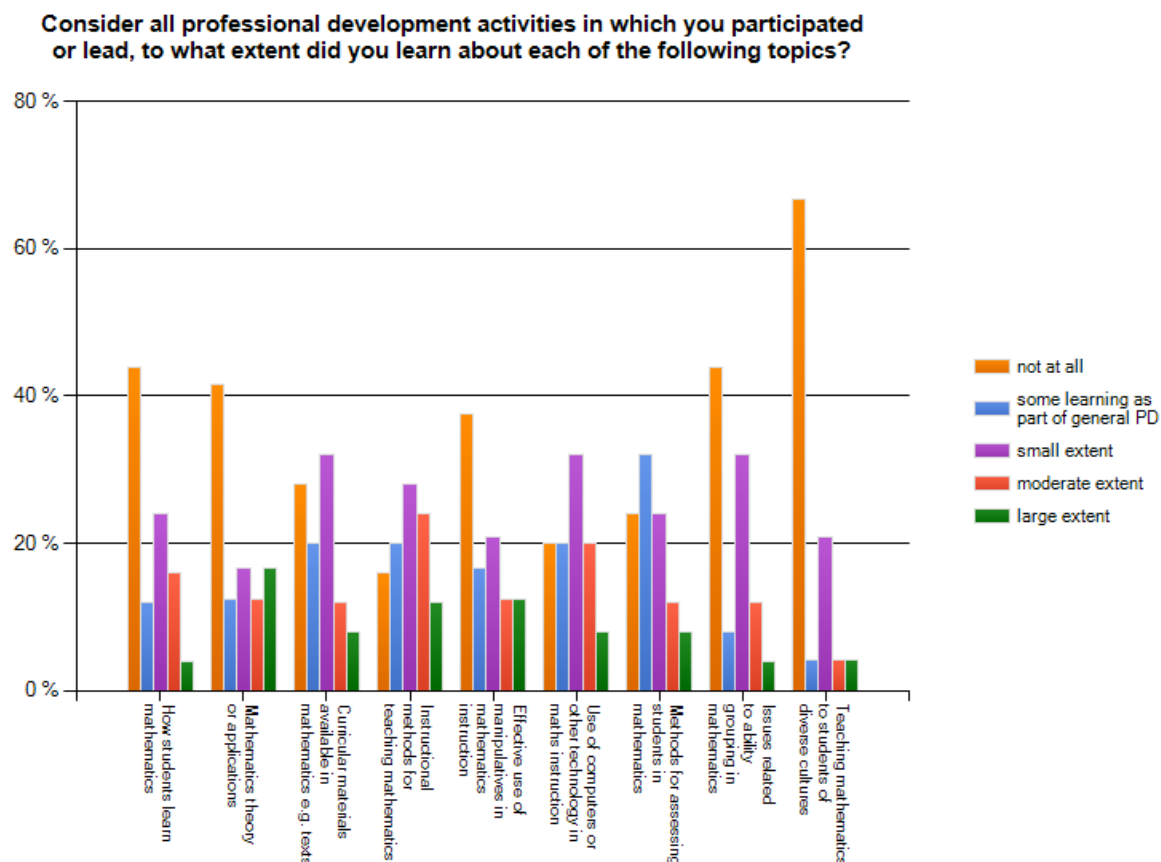


Figure 5.7: Content learned through professional development by percentage of teacher respondents

The orange columns to the left of each content area show the percentage of teachers who did not cover these professional development activities at all. 44% had not learnt how students learn mathematics, nor issues related to ability grouping, in the previous three years. 66.7% had received no professional development covering the teaching of mathematics to students of diverse cultures. 37.5% had not covered the effective use of manipulatives in mathematics instruction and 28% had not covered curricular materials available in mathematics. 24% had not covered methods for assessing students during their professional development in the previous three years, whilst 20% had had no coverage of computers or other technology and mathematics instruction, and finally, 16% had not received

any professional development on instructional methods for teaching mathematics.

The largest percentage for topics learned to a large extent, through professional development in the previous three years, was 16.7% for mathematics theory or applications.

## **5.5 The effectiveness of professional development in mathematics**

In an identical way as School A, this section sought to explore the perceptions of the Principal and teachers of School B about the effectiveness of particular types of professional development and to establish any alignment with researched best practice in professional development types and effectiveness.

### ***5.5.1 Perceptions of the effectiveness of professional development in mathematics***

Principal B stated that the professional development in mathematics they had received had had a large positive impact personally but only a moderate positive impact on staff and students.

11.5% of School B teachers believed that the mathematics professional development they participated in had a large positive impact on their pedagogical practice, 19.2% recorded a moderate positive impact, 42.3% recorded a small positive impact and 26.9% said that it had had no impact on them.

In relationship to student achievement, 11.5% of School B teachers recorded that their professional development had a large positive impact on the students, 23.1% believed that it had a moderate positive impact on student achievement, 42.3% thought it had had a small positive impact, 19.2%

considered that it had no impact and 3.8% thought it had had a negative impact on their students.

Principal B maintained an opinion that the individualistic approach they took to designing School B teachers' professional development participation, to improve mathematic pedagogical practices and knowledge, was close to what they considered ideal:

*The ideal is that we assess each teacher - where they are at, what they know, what they don't know... but, also, what they don't know but don't know that they don't know... So the ideal is personalised development to each teacher.*

School B teachers stated that they considered that the one-day workshop approach to professional development lacked consistency and sustainability. They recognised that these single workshops did not allow for change to occur:

*If you really want to get something to go properly, one day a week for a term and I think you'd see some real change in people, especially if there were some... you are only as good as your follow-up. One offs aren't going to happen.*

In this statement the School B teacher has recognised the need teachers have for space and time to reflect on current pedagogical practice as well as explore and implement new practices they are being introduced to.

### **5.5.2 Perceptions of the most effective types of professional development in mathematics**

The Principal and the teachers were asked to select from a list of options, which described a range of professional development methods, and to rate them according to their perception of what would be most effective. They were able to select more than one option.



Principal B's selections indicated a belief that one-day workshops or training sessions, conferences, mentoring, in-school as part of staff development, individual research, and professional learning groups were the most effective methods for their personal professional development. The selections illustrated that Principal B believed that a smaller selection of professional development methods was most effective for the School B staff. These included mentoring and/or coaching as part of a formal arrangement, and in school (as part of staff development) professional development.

School B teacher responses are illustrated shown in Figure 5.8.

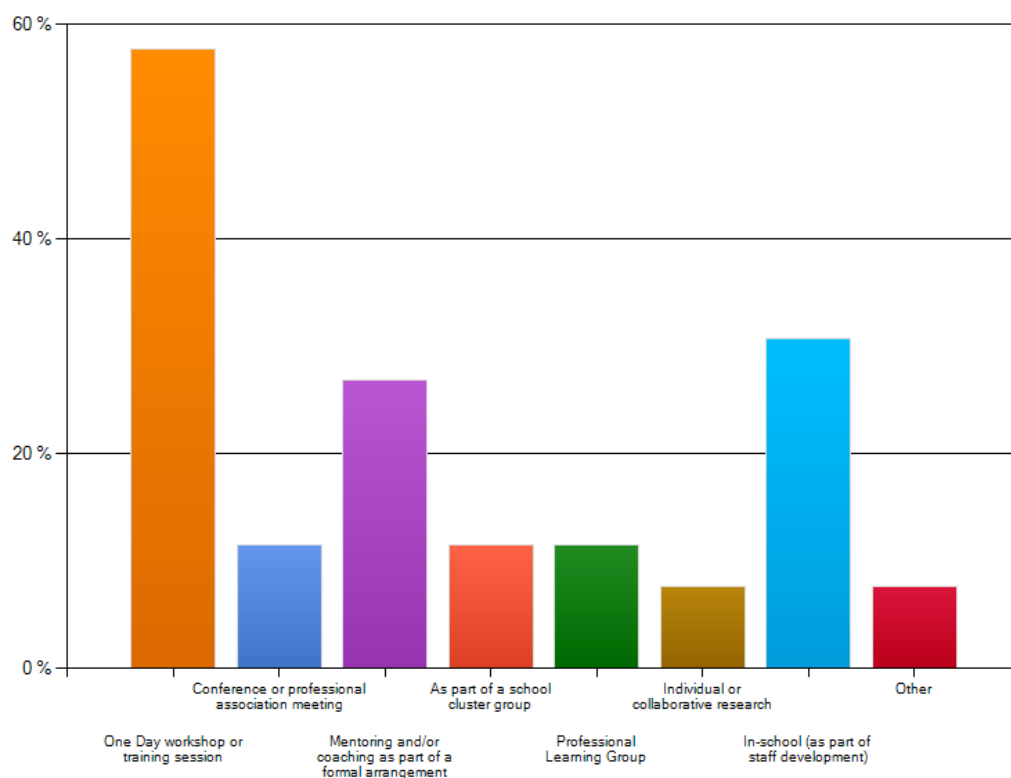


Figure 5.8: Perception of effectiveness of professional development

57.7% of the teachers indicated that they considered a one-day workshop or training session as the most effective form of professional development. In-school professional development was rated by 30.8% of responses and 26.9% selected mentoring and/or coaching as part of a formal agreement as being effective professional development. 11.5% supported a conference or

professional association meeting, a 'professional learning group', and/or professional development as part of a school cluster group. 7.7% rated individual research and unspecified 'other methods' as the most effective type of professional development.

## **5.6 Impediments to accessing professional development in maths**

In the survey Principal B was asked to identify any impediments to accessing professional development in mathematics. Principal B recorded: "Time factors in relation to other initiatives."

## **5.7 Principal B's leadership of mathematics**

In relationship to a principal's role as a leader in mathematics, Principal B outlined a view that principals need to comprehend the intent of the curriculum and the achievement requirements for all students in the school but Principal B positioned them as not needing to understand the content of mathematics nor like the subject:

*We need to understand what is the aim of the curriculum is, in maths specifically, too. I don't think a principal has to be mathematically orientated or have a bent in mathematics but, certainly, has to understand that mathematics is one of the foundation skills. If they don't, they are in danger of compromising the child's development.*

In response to a survey question that asked Principal B to indicate their perceptions of their leadership in mathematics (Full control; mentor; coach; delegate; distributive, and; facilitative leadership) the option selected was distributive. No further written clarification was offered. In interview Principal B provided the reasoning for the leadership style they employed in mathematics:

*I think that the powerful way that we delegate and share leadership more linearly is essential. Looking at teaching maths, many of the staff just cannot*

*do it. We need to share (leadership) to those who have a passion but also have an understanding. It's not good enough for a teacher to struggle with a maths concept that they don't understand because, immediately, the child disengages... it compromises the integrity of the teaching but also compromises the faith the child has in the teacher because they know that the teacher doesn't understand.*

Principal B articulated a belief that through delegation in a flow down process those teachers who lacked understanding or skill in mathematics pedagogy or knowledge would gain this from lead teachers who had best practice and enjoyment of mathematics.

The School B teachers recorded a response to a similar question on the teacher survey. 56.0% stated that the Principal delegated. One teacher added a note stating: I think the Principal delegates to the Maths Curriculum Leader who operates on behalf of the Principal, and I don't have a problem with that. Another teacher recorded: We have a head of Maths.

20% of School B teachers thought that distributive leadership was the Principal's preferred style, 16% recorded a facilitative approach, 4% described the Principal's approach as mentoring, and 4% thought of the Principal as a coach. One teacher who recorded no selection wrote: Have absolutely no idea of Principal's role in maths.

#### **5.7.1 Reinforcement of mathematics professional development**

As stated in Chapter 4, professional development must lead to a change in classroom practice or it is of no use. A measure of professional development effectiveness is to analyse the difference between expected result and the sustainability of its implementation in the classroom. This requires that an educational leader implement procedures to reinforce the learning from the professional development. The survey asked if reinforcement activities were put into place.

Principal B responded to the question saying, “A full time facilitator next year.” Principal B described reliance on a quality assurance system that involved a management team approach to ensure implementation of learning from professional development:

*It used to be the Principal that (did) quality assurance... Now, we make sure that leaders that... have more engaging influence with the classrooms do the quality assurance... the Principal's job is to make sure it happens or make sure that the resources are there to make it happen. I think we are shifting to where the Principal has the influence to make something happen, not necessarily leading what it is that has to happen.*

The teachers were asked to reflect on the Principal’s reinforcement activities. Their responses are illustrated in Figure 5.9.

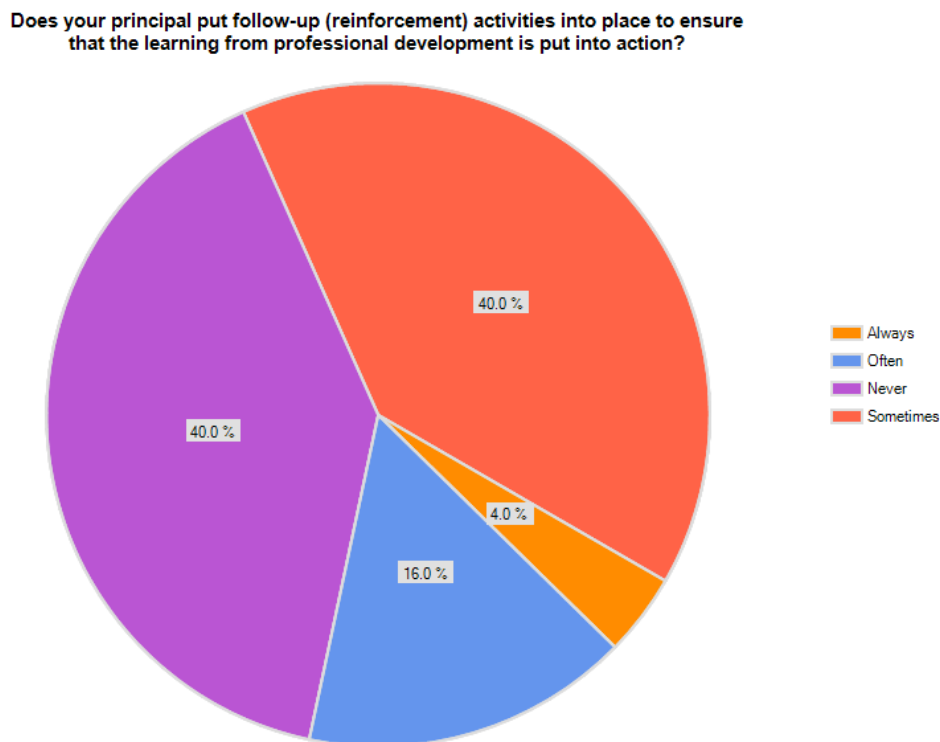


Figure 5.9: Perception of frequency of reinforcement activities by percentage of teacher respondents

40% of respondents stated that the Principal did not put follow-up activities into place and a further 40% believed that he sometimes put reinforcement

activities into place to ensure that learning from professional development was put into action in the classroom. In contrast 16% said that such activities were often put into place and 4% said that they were always put into place. Despite 80% of the teachers' perceptions that the Principal seldom used a follow up procedure to ensure sustainability of the new learning in interview they voiced knowledge of the necessity of reinforcement and follow up for the 'expected result – implementation' gap to be improved:

*Tracking it and of making sure that people are doing it, forces them to put it into their program. If it is good then people see the benefits and keep on going with it.*

#### **5.7.2 Participation in discussions with staff about mathematical pedagogy**

Principal B recorded in the survey that they discussed mathematics with their staff once a week. Further discussion in interview clarified this answer:

*About maths, it depends. It is variable. It depends on what has been written, what's been reviewed, or what has been analysed and it varies at different times of the year... Sometimes, when we talk about pedagogy, we talk about the pedagogy of maths. It is variable. It would be as often as any other subject. It would be no less than any other subject.*

In contrast 88.5% of teachers perceived that they 'seldom' participated in discussions about pedagogy in mathematics with Principal B. 7.7% estimated that the Principal's participation in discussions about pedagogy in mathematics was once a term (10 weeks in New Zealand) and only 3.8% of the teachers agreed with the Principal's estimate. Further probing in the focus group drew an attitude that suggested that the teachers did not expect direct discussion about mathematics. As one teacher stated:

*But his job is to support you through discussions. It is your job to set the goals. If you were the maths leader, it would be your job to set the goals,*

*develop the action plan, share that with him and have a discussion around that and agree or disagree.*

### **5.8 Teacher perceptions of the Principal's promotion of, and participation in, professional development in mathematics**

46.2% of School B teachers recorded that the Principal never participated in professional development in mathematics. 30.8% stated that this occurred less than once each year. A further 11.5% said this occurred approximately once each year and 7.7% of teachers recorded that the Principal's participation was twice a year, whilst 3.8% thought it was more than twice a year. Figure 5.10 illustrates these responses.

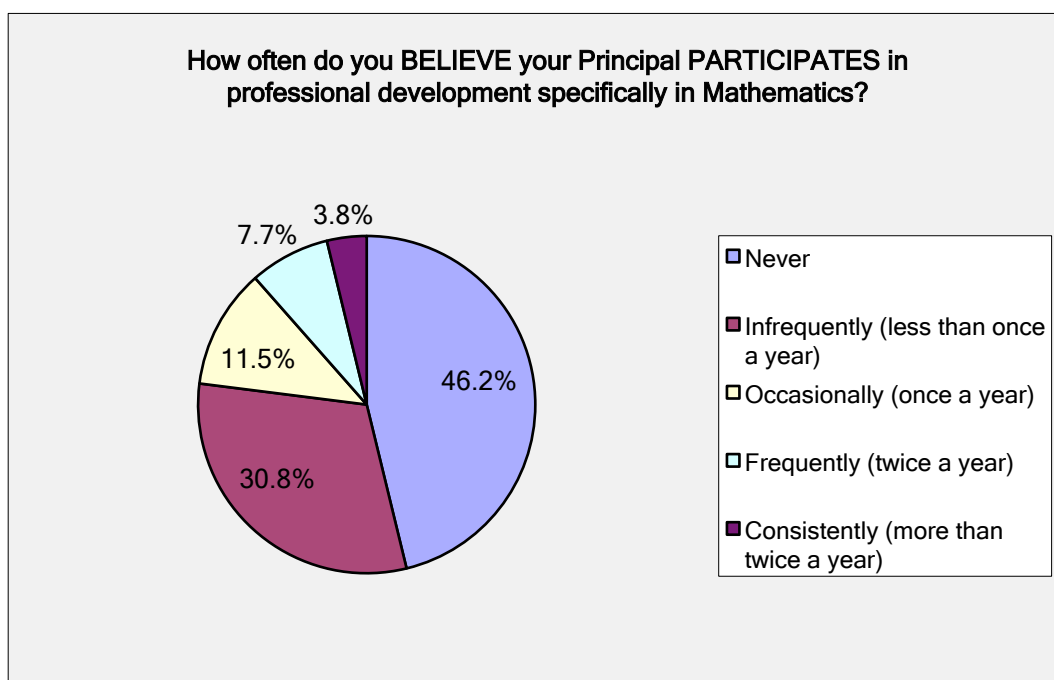


Figure 5.10: Teacher perceptions of Principal B's participation in mathematics professional development

In further discussion, teachers in the focus group outlined how they considered that Principal B's participation was inadequate in professional development and staff meetings:

*We are actually seeing less and less participation of our leader in staff meetings.*

*I would have to say that I have seen none.*

*I think (Principal B)'s approach would be to be hands-off with any sort of curriculum drive. I don't hear, in any curriculum areas, of (Principal B) driving anything.*

A survey question also asked the teachers how well they believed the Principal promoted teacher access to mathematics professional development. 42.3% responded that the Principal did not promote access for them at all, 30.8% responded that the Principal promoted access a little, 11.5% answered that they believed that their Principal moderately promoted access with a further 11.5% thought the Principal promoted access 'well', and the remaining 3.8% described the Principal's promotion of access to mathematics professional development as done extremely well.

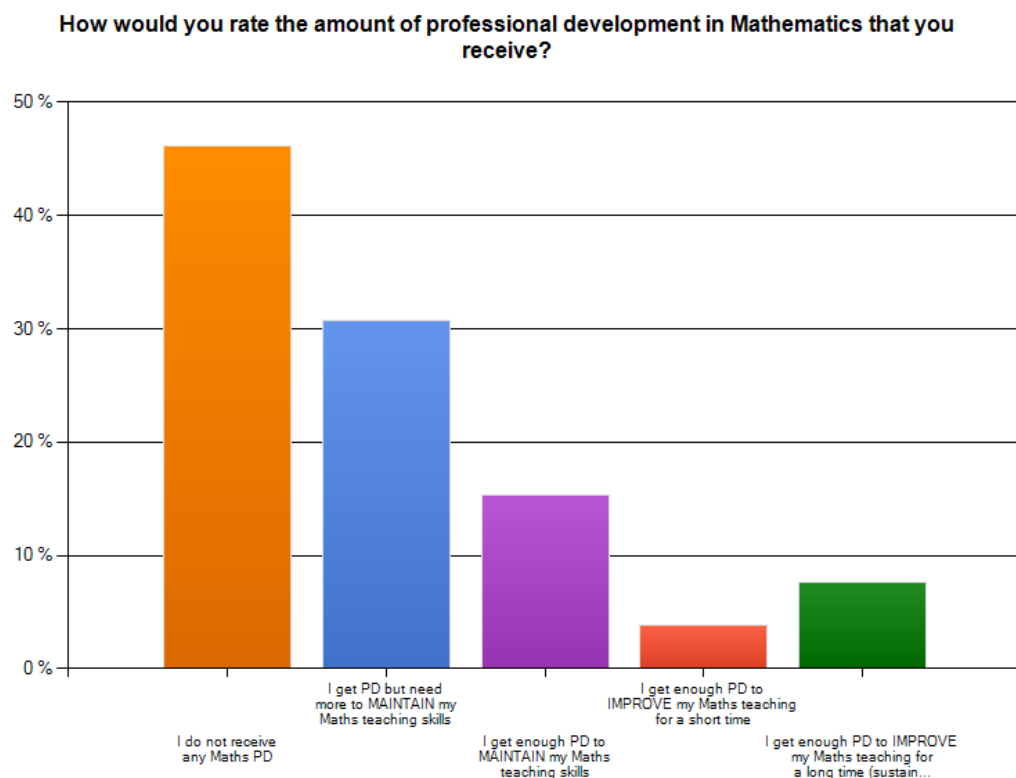


Figure 5.11: Perception of amount of mathematics professional development received to aid mathematics teaching.

When asked to rate the amount of professional development in mathematics that they received against the maintenance of, or improvement in, mathematics teaching skills, 7.7% of teacher respondents believed that they had enough professional development to improve their mathematics

teaching for a long time (sustainable improvements). 3.8% got enough professional development to improve their mathematics teaching for a short time and 15.4% got enough to maintain mathematics teaching skills. 30.8% responded that they needed more professional development to maintain their skill and 46.2% said they did not receive any mathematics professional development. Figure 5.11 shows the responses in a graphical format.

### ***5.9 Teacher perception of how well they believe the Principal leads professional development in mathematics***

The final survey question (Overall, how well do you believe that your Principal leads professional involvement in mathematics?) was designed to analyse teacher perceptions of the Principal's leadership of professional development in mathematics. Figure 5.12 shows the responses.

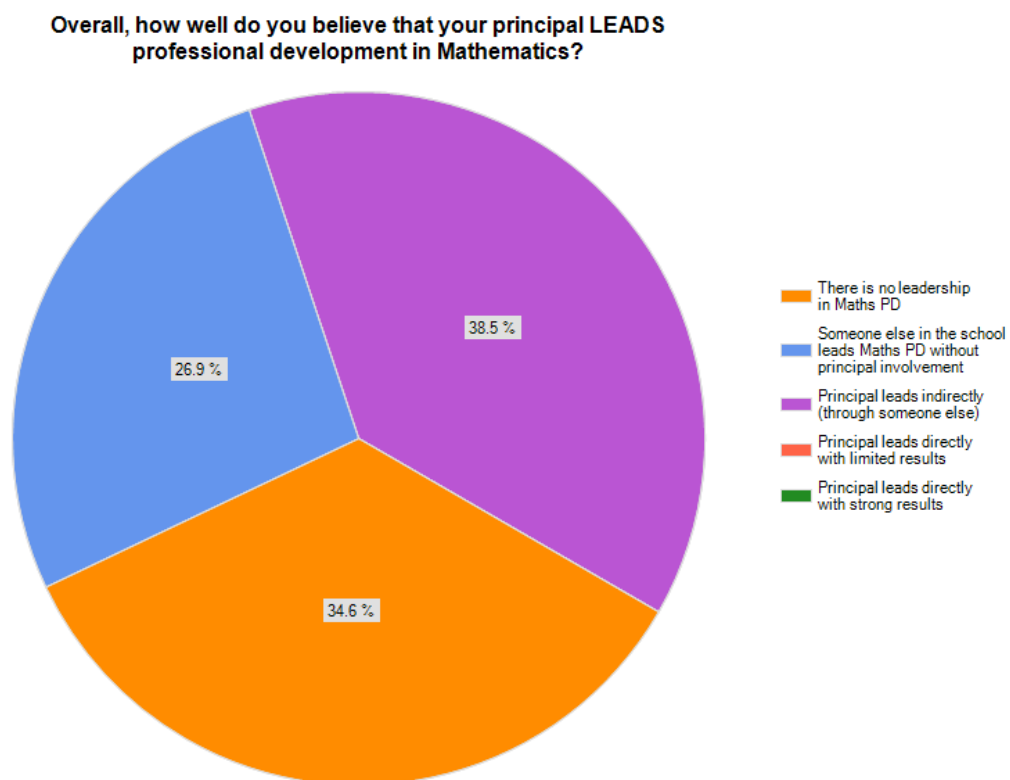


Figure 5.12: Perception of leadership of professional development in mathematics

34.6% of respondents recorded that there was no leadership in mathematics professional development by the Principal. 26.9% noted that someone else in the school led professional development in mathematics without any



principal involvement and 38.5% believed that the Principal led indirectly (through someone else). There were no responses as to whether the Principal led directly with either limited or strong results.

The focus group participants voiced a belief that the Principal should uphold his explicit leadership in curriculum. As one teacher said that the Principal:

*can't abdicate responsibility for curriculum because ultimately (s/he) is the person who is responsible for the learning of the school... Ultimately, the buck stops with (her/him) because if kids are failing and not achieving the ERO, the community, and the Board would all be on (her/his) tail.*

Principal B justified the current leadership approach in mathematics:

*I think that maths is extraordinarily well led here. I think the leadership is very good. It's not out there but it is consistent and you can follow programs and websites that are suggested all the way through.*

The teachers stated that not all teachers saw Principal B's version of shared leadership as being ideal for them, especially in mathematics. Unanimously they expressed a need for another form of curriculum leadership in the perceived absence of the school leader. The concept of curriculum teams as an option was suggested under the shared leadership philosophy. However, in further discussion the teachers outlined how they felt that the leadership team no longer led curriculum due to changes in the leadership team's roles. A teacher said:

*If you look at the way their roles have changed, they are more into HR, International students and all that kind of thing, and the whole curriculum focus has been lost from a senior management point of view.*

Whilst another stated:

*It seems to have dropped, I think, our promotion of maths. It seems to have dropped from the leadership role to the next stage down.*

## **CHAPTER 6: DISCUSSION AND CONCLUSION**

The previous two chapters each analysed data for a school in isolation. This chapter will attempt to bring the two sets of data together for comparison in order to identify patterns of practice and to analyse those patterns of practice from a research base.

### **6.1 Introduction**

The aim of this research was to explore how a school leader's mathematical identity affects their leadership of professional development in mathematics. This involved an examination of the mathematical identity of two Principals, their approaches to educational leadership in mathematics, choices made regarding professional development provision in mathematics, and the impact this had on teachers' mathematical identity. The research placed particular focus on the practice of distributed leadership and the promotion of, and participation in, professional development by the school leader. A secondary focus was on the effectiveness of the professional development approaches engaged in, considered in line with research-based best practice.

Although both schools included in this case study showed a strong will towards student achievement in mathematics and both verbalised an understanding of the necessity of mathematical knowledge in the 21<sup>st</sup> century, the provision of professional development and educational leadership in mathematics diverged. There are, therefore, a number of issues to consider. In this chapter those issues are discussed, implications considered, and suggestions for further research outlined.

## **6.2 Mathematical identity of Principals**

Common sense might suggest that a principal with a strong mathematical identity would identify more strongly with the subject and, therefore, focus on the provision of effective professional development specific to mathematics. Such a focus would be expected to lead to improved classroom practice in mathematics by improving teachers' mathematical content knowledge and pedagogy. This research did not provide evidence for a positive correlation between strong mathematical identity and a focus on provision of professional development in mathematics. Indeed, a stronger relationship became apparent between a formerly weak mathematical identity that had been addressed and the promotion of, and participation in, mathematical professional development than the relationship between a strong but unaddressed mathematical identity and promotion of, and participation in, mathematics professional development.

Principal A did not connect to mathematics content as a school student because they explained that they were "one of those kids who didn't get it at school". They ceased to formally study mathematics for the university entrance examination at High School. Principal A's statements consistently referred to indicators of a weak mathematical identity as a child. Fiore (1999) shows that the origins of mathematics anxiety lie in childhood experiences and teachers with maths anxiety pass it to their students. In a socio-cultural sense, as examined by Black and colleagues (2009), the classroom practices that Principal A had received in mathematics failed to raise the Principal's level of proficiency, whilst, psychologically, the education received failed to relationally bridge student and subject as described by Grootenboer and Zevenbergen (2008). Weak mathematical identity was the result. In hindsight, Principal A recognised the use of mathematics as a young adult when working in authentic contexts but did not connect this usage as being mathematical at the time. Principal A appeared not to have linked the actions and the objects of the actions to the mathematical

performance of the actions, a necessary link according to Sfard (2008), thereby maintaining a weak mathematical identity. The length of time that Principal A experienced a weak mathematical identity corresponds with Jackson and Leffingwell's (1999) estimate for it lasting 20 years or more. Ten years after leaving school Principal A entered a teacher education program and, through the program, started to change their perception of their mathematical identity and potential for mathematical understanding. Having realised that success in mathematics was achievable, Principal A was proud to achieve high-level results at the end of the program. Grootenboer and Zevenbergen's components of identity offer an explanation of why this change occurred, i.e., by changing elements of identity (such as a new path for their life history and improved affective qualities and cognitive dimensions for mathematics) Principal A addressed the weak mathematical identity that had troubled them through their life journey up to that point. Principal A's position on Luttrell and colleagues' (2010) Mathematics Value Inventory, as adapted for use in this study (Table 4.1), indicated that they had successfully repaired their mathematical identity and their statements in interview provided evidence that they continue to work at improving their mathematics identity.

Successfully addressing mathematical identity gave Principal A an insight into students who struggle in the subject and that the methods that teachers use affect student understanding. Principal A also demonstrated that mathematical ability was not fixed. This created a clear purpose for teaching mathematics and subsequent school leadership, simply described by Principal A as being that a child in their care "would not suffer a belief that they were mathematically useless". Principal A has since shown enthusiasm for professional development in mathematics content and pedagogy, having taken part in professional development for the introduction of the constructivist based New Zealand curriculum statement for mathematics in 1992, the Numeracy Project, and the revised curriculum of 2007.

In contrast, Principal B described having a lifelong comfort with mathematics that Principal A did not, indicating a positive mathematical identity from an early age and having studied mathematics content at university. Their responses to the statements of the MVI scale indicated that Principal B held mathematics to have a high value and showed no mathematics anxiety despite a lack of professional development in the subject. Principal B's emotional relationship was undiminished despite a fading knowledge base. Principal B demonstrates Walshaw's (2010b) observation that the conscious and the unconscious aspects of a mathematical experience cannot be separated.

From a postmodernist schema, mathematical identity is not fixed but is fluid over time (e.g., Bibby, 2009). The journeys taken by the case study Principals towards addressing mathematical identity showed contrasts that have led the Principals to their current relationships with mathematics. The study showed the 'repaired' mathematical identity of Principal A being positively applied to their beliefs about teaching mathematics in their school. This is in direct contrast to the original strong mathematical identity of Principal B that had not been further nurtured, either professional development or personal interest. The reparation of Principal A's mathematical identity led to a different and more active level of educational leadership in the promotion of, and participation in, professional development in mathematics than Principal B. In Principal B's case, this positive identity had been left unattended, i.e., not progressed through professional development of mathematical pedagogy, over a period of significant change in the pedagogy of mathematics. Both Principals agreed that mathematics and literacy are the core of the curriculum but the level of attendance towards improving mathematical practice appeared to correlate to their levels of mathematical identity.

Having established a relationship between addressed and unaddressed mathematical identity and attending to a personal and professional improvement in mathematical content knowledge and pedagogy, the next

section addresses the educational leadership approaches, towards mathematics, utilised by the Principals in this case study.

### **6.3 Educational leadership of mathematics in practice**

The previous section explored the two Principals' mathematical identities as a psychological lens through which to view their relationship with mathematics. This section seeks to address the way that the Principals approached their role as educational leader in their school, specifically towards mathematics. The section examines and acknowledges the complexity of the modern role of the Principal and then seeks to explore the type and level of personal involvement of the Principal in professional development for mathematics.

#### ***6.3.1 The impact of administrative needs on the complexity of the Principal's role***

Both Principal A and Principal B acknowledged the impact that the complexity of their role had on their ability to lead mathematics and other curriculum areas. It was the way they prioritised tasks in response to this complexity that differentiated them from each other as educational leaders. Dalin and Kitson (2004) have stressed the importance of administrative duties to achieve school objectives whilst Fink and Resnick (2001) conclude that it is these same functions that have led to a loss of connection with teachers. Losing connection with teachers through a focus on administration implies disconnection and managerial diversion of leaders from classroom practice and pedagogy in action (Fullan, 2008).

Both Principals espoused their belief that their main goal should be to encourage learning but Principal A viewed administrative and managerial activities within the context of encouraging learning rather than as ends in themselves. This view of administration being aligned with learning complied with the recommendations of the Ontario Principals' Council (2009) to

Principals. Whilst recognising that leading student achievement in mathematics through being frequently in the classroom was not practical, Principal A stated that they would never consider missing a staff meeting, as a form of professional development used in School A. Principal A considered classroom visits to evaluate mathematical teaching practice as a task that had priority over other administrative demands. Based on the teacher comments at School B, it appeared that Principal B set other priorities above attending staff meetings for professional development in mathematics and did not do classroom visits for the purpose of evaluating the teaching and learning of mathematics. Principal A practised what Stewart and colleagues (1997) opined in their work, that a principal should champion the vision of how teaching and learning can be effectively developed and address administrative needs in accordance with teacher and student professional needs. By not participating in professional development on constructivist approaches in mathematics, Principal B was not involved at a level where they could influence classroom practice or objectively identify teacher and student needs. Whether this could be the sole fault of the complexity of their role was beyond the scope of this research but Principal B did appear to reflect Spillane's (2005) findings of less leadership profile and different leadership routines applied to mathematics when compared to other curriculum areas.

Research demonstrates that the complexity of the principal role is better managed through a distributed leadership model in contemporary schools, e.g., Copland and Knapp (2007) and Harris (2008). The next section discusses the contrasting use of distributed leadership in the two case study schools.

### **6.3.2      *Distributive leadership of mathematics in the case study schools***

Although both Principals described their leadership approach as distributive, they demonstrated contrasting positions from the perspective of Anderson's Model of Leadership Reciprocity (2004). Principal A was firmly positioned within the 'Interactive Model' as evidenced by their own and School A's teacher statements. Accessibility between the Principal, the lead teacher of mathematics, and other School A teachers was shared equally and communication between the constituent members was free flowing. Curriculum team meetings and whole staff meetings were used as the prime means of making accessibility and communication explicit. Principal A expressed confidence in the lead teacher of mathematics and the mathematics curriculum team, recognising their high level of content knowledge. However, the Principal continually asked questions to improve the Principal's and other teachers' understanding of mathematical content and pedagogy in public forums, demonstrating that they were the lead learner alongside the rest of the staff.

Principal A's openness and respect had built relational trust with the teaching staff in terms of mathematics. It was outside the scope of this study to consider if that trust extended further. Survey responses demonstrated an overall trust in the curriculum team and leader's ability to gain sound levels of student mathematical achievement. Robinson and colleagues (2009) describe building relational trust as one of the four leadership 'knowledge, skills and dispositions' (KSDs) required to engage in the leadership dimensions that best affect student outcomes. There was a clear consensus that student achievement was the core business of the school and, reflecting the research of West and colleagues (2000), teachers recognised this goal and the need to improve their practices towards it. In addition to modelling their own personal development through highly visible participation in mathematical professional development and being seen as the lead learner



in mathematics at School A, Principal A reinforced the role of educational leader in mathematics by promoting staff access to mathematical professional development and providing the necessary strategic resourcing needed to ensure that access. In addition, they also learnt to coach and mentor teachers effectively in mathematics in the manner identified by Nelson and Sassi (2005).

Statements from School B's teacher's and Principal B positioned the Principal in either the 'Contested Model' or the 'Buffered Model' of Anderson's Model of Leadership Reciprocity (2004). It was outside the scope of this research to establish if the lead teacher for mathematics contested control of the curriculum area with the Principal or whether other team members were required to go through the buffer of the lead teacher for mathematics in order to access professional development in mathematics or mathematical resources. However, the weight of evidence gathered from teacher and Principal's statements was that the buffered model was most likely. The Principal stated their view that mathematics "is extraordinarily well led here" (p.112), indicating a lack of contention over the control of the mathematics curriculum area.

In spite of a strong mathematical identity, Principal B described the subject as challenging and did not demonstrate a profile in professional development in mathematics. The research of Schorr (2000) showed that, in such circumstances, Principals tend to limit themselves to ensuring a supportive environment for professional development. In general, Principal B stated that they did provide the strategic resources to enable professional development but the absence of strategic direction towards mathematics and a lack of participation in professional development in mathematics meant that the support was without structure or priority.

One of the aspects of successful distributed leadership models, as identified by the National Quality Schools Framework (2003), is to develop and maintain high-level *shared* knowledge about curriculum and instruction.

Principal B was not a part of the community that shared knowledge about mathematics but stood outside of it. Evidence from the statements made by the teachers indicated either a declining participation by the Principal in mathematics professional development or no participation at all. By relinquishing the educational leadership of mathematics to the lead teacher and not interacting with the wider teaching body in a reciprocal manner, Principal B was perceived by the teachers as abdicating responsibility, in a similar way to that shown by the research of Degenhardt and Duignan (2010). The Principal was considered to be more concerned with the study of pedagogical improvement rather than the practices that would lead to the improvement itself.

This section has shown contrasting use of distributive leadership by Principal A and Principal B in terms of educational leadership of mathematics. The following two sections examine the most obvious ways that the Principals differed: their personal participation in professional development activities and the strategic identification of professional development needs for effective classroom practice in mathematics within their schools.

## **6.4 Professional development**

Having examined the contrasting educational leadership approaches of the two case study Principals, this section will explore how the approaches impacts on the professional development plan for mathematics.

### ***6.4.1 Principal participation in professional development***

The core of building leadership and pedagogical capacity in schools lies in how the Principal focuses on the development of teachers' knowledge and skills (Fullan, 2002). Robinson and colleagues (2009) identify that the promotion of, and participation in, professional development by a school leader has the largest effect size on student achievement.

Principal A improved both their own knowledge and their influence on teacher practices by providing educational leadership whilst sharing in the learning about mathematics alongside the teaching staff. By maintaining a programme of personal professional development Principal A fulfilled one of the five important themes in educational and professional leadership expounded by Stewart, Prebble, and Duncan (1997). Participation in mathematics professional development reflected the attitude of Principal A towards teacher learning and its effect on student identity and achievement in mathematics. Being involved in the learning as well as leading instructional improvements meant that Principal A was available for, and encouraged, regular discussions with staff on mathematics.

Many, if not most, New Zealand Principals were educated in school mathematics prior to constructivism being introduced in the 1992 New Zealand Curriculum and may not have taught in a classroom using constructivism. Nelson and Sassi (2005) raise the question of how much and what kind of knowledge is sufficient in order for Principals to be effective educational leaders and to be able to make effective decisions regarding instruction. If a Principal has not been indoctrinated in a mathematics pedagogy based on classroom discussion of the students' own ideas and solutions to problems and moved away from individual work and textbook content, they are unaware of strategies that are, in the words of Wood & Turner-Vorbeck, (2001), fundamental to children's learning. Principals who have not undertaken ongoing professional development in mathematics may not recognise, nor provide for, excellence in mathematics teaching and learning.

Principal A used memories of a weak mathematical identity as a springboard to promote, and participate in, professional development in contemporary mathematical pedagogy. Each member of staff at School A underwent consistent professional development in the Numeracy Project and this is reflected in the high level of MVI scores and a lack of mathematical anxiety in the staff. Some of the staff at the school admitted to having had a low

academic self-esteem in mathematics as students but attendance to mathematics during initial teacher education and subsequent in-school professional development led to a team of teachers who were confident and capable of delivering the mathematical learning opportunities necessary for student achievement. Nelson and Sassi (2005) tell us that the nature of a principals' mathematics knowledge affects their appreciation of mathematics instruction in their schools and it was apparent from the survey, personal interviews, and focus group interviews that Principal A participated in mathematics-based professional development to a degree that they were well enough informed to have been able to make decisions regarding instruction. By being consistently involved in professional development in mathematics, Principal A had also built relational trust with the curriculum team, and other members of staff with respect to this curriculum area.

Teachers at School B did not perceive Principal B as promoting, or participating in, mathematical professional development. The teachers professed to have no knowledge of the mathematical background of their Principal, as they had never observed the Principal engaged in mathematical tasks or facilitating mathematical pedagogy. From Principal B's perspective, there was no need for the teachers to observe the Principal participating in mathematics as he or she had 'shared' the leadership with the lead teacher of mathematics and had given full responsibility for development of this curriculum area. It was clear that the teachers did not see the Principal as the leader of the curriculum area or to be a member of a leadership team for mathematics. It was also apparent that the teachers in the focus group had undertaken little mathematical professional development.

It is acknowledged that distributive leadership is a key component of contemporary schools. Lindstrom and Speck's (2004) four roles of an effective professional development leader include that of being a 'builder' by preparing capacity in the school. Distributed leadership sets the enabling culture for building capacity. However, a Principal must also understand the impact they have on the individuals within an organisation. Statements from

the Principal showed that Principal B did not participate in professional development in mathematics and had not done so for several years. Principal B could not engender relational trust with regards to mathematics because of the lack of specific promotion of professional development in mathematics and the Principal's personal absence from professional development. It is worth recalling that 'building relational trust' is one of the four 'knowledge, skills and dispositions' required for leaders to engage with the dimensions that affect student outcomes most effectively (Robinson and colleagues, 2009). School B teacher's statements about the lack of professional development activities offered in mathematics, the lack of frequent discussions with teaching staff about mathematics, and the absence of classroom visits and discourse are evidence that Principal B's hands-off approach to mathematics led the Principal to a limited appreciation of how and when to help initiate change in mathematics, as expounded by Nelson and Sassi (2005).

Principal A showed ongoing and collaborative reflection with senior leaders, the curriculum team and other teachers, concerning the implementation of the learning from professional development, as applied in the classrooms. Identification of gaps between expected outcomes of professional development and observed implementation in the classroom is critical for a Principal if resources are going to be effectively targeted. Through the system at School B, Principal B was not in a position to measure the 'expected outcome - actual implementation' gap of professional development activities because there were no classroom visits or discourse. The Principal's statement that teachers should choose their own professional development path (p. 103) implied that they purposely avoided a structured professional development plan for mathematics. As Principal B operated within Anderson's (2004) buffered model of leadership reciprocity, it would be unlikely that they were aware of the need for professional development in mathematics as verbalised in the teachers' interview without classroom visits. As such, there was no awareness of the need to address the weak mathematical identities of the teachers at School B.

Argyris (1992) spoke about the gap between espoused values and theory in use. Principle A described a wish for all students in their school to achieve mathematically and provided professional development to the people most able to facilitate this goal - the teachers. Such was their commitment that they got personally involved in the professional development and acted as a role model and lead learner in mathematics at their school. Principal B also espoused the importance of mathematics when they stated, “a principal... has to understand that mathematics is one of the foundation skills. If they don’t they are in danger of compromising the child’s development.” However, the theory in use was that mathematics was of no more importance than any other curriculum area, in spite of the espoused theory that there was a high value placed on mathematics for a student’s development, despite the New Zealand Government’s emphasis on mathematics and literacy in the introduction of National Standard for those areas, and despite the weak mathematical identity of the teachers at School B.

Argyris (1992) also states that the people in a change process may be unaware of, or choose to stay unaware of, a lack of skills and that this may be related to the suppression of feelings. To delve into the psychology of Principal B, in order to establish if this was the case with regards to the provision of professional development in mathematics at School B, is beyond the expertise of this researcher and outside the scope of this study.

#### ***6.4.2 Identifying the professional development needs of teachers***

Evidence was provided in Chapter 4 that Principal A consulted with and considered the needs of individual teachers in the development of the professional development plan. In addition, teachers’ pedagogical practices were observed through classroom visits, weaknesses were identified, and student achievement data was analysed before goals for professional development were established. Principal A designed the professional development plan (the second of Lindstrom and Speck’s (2004) roles of

effective leaders of professional development) using clarity and consensus about the context and needs of the school, developing plans based on real needs, identified by the teachers themselves or through data collection and classroom visits.

In School B, the lack of classroom visits and inquiry into mathematical pedagogy had negatively affected the design of an effective and focused professional development plan. This approach was not appreciated by the teachers at School B, as evidenced by such comments as, “we should be setting some strategic direction and goals... give people the opportunity to go and look at best practice in classrooms.” Statements made by both Principal B and the teachers at School B highlighted the lack of classroom visits as affecting the design of the professional development plan, (e.g., verbalised by a teacher who said, “set up some observations because, unless you actually teaching with someone watching, how are we going to monitor any pedagogical improvement?”).

Principal B believed that teacher effectiveness in mathematics could be measured by comparing the results of students’ start and end-of-year mathematics tests. The fact that this review did not lead to any strategic approach to professional development was shown in the findings that School B’s teachers participated in a wide and discrepant range of professional development activities with mathematics as the second lowest curriculum area to be engaged. The teachers stated that School B participated in too many initiatives, which resulted in a lack of focus for professional development programs. They found that there was little time to collaborate, reflect and gather data on mathematics with no opportunity, therefore, to achieve Schmoker’s (2005) big and immediate dividends in student learning. School B’s professional development offered a ‘Smorgasbord’ approach as described by Wood (2003). This was done with the intent of providing personalised professional development for each teacher but was based on the identification of pedagogical needs by the individual teacher themselves and not on data or observation. School B’s in-school professional

development program centred on a coaching program, identified by Lindstrom and Speck (2004) as one of the most effective forms of improving classroom practice (detailed in table 2.1). However, once again, the teacher identified his or her own coaching goals, i.e., the same person that identified their own personalised professional development plan. Therefore, if the teacher did not know what they did not know, or if their mathematical identity was so low that this cognitive effect turned into a behavioural response of avoidance of participation in mathematical professional development, as described by Richardson and Suinn (1972), then there was no mechanism to ensure that students were achieving a good mathematical education.

Argyris' (1990) model of theory-in-action gives a useful tool with which to analyse why the two Principals were so different in their design of the professional development plan. In particular, the ladder of inference is extremely valuable in identifying the divergence. Both schools had the same level of available data. The Principals' statements provide evidence that they both had student achievement data on which they based judgements. They both had teachers who are able to offer overall teacher judgment on student achievement and who may have reflected on their own capabilities in mathematics, as they did for this study, and classrooms visits were possible in both schools. However, from this pool of available information, Principal A selected a wide range of information, (e.g., data analysis, discourse, and classroom visits) on which to base descriptions of teacher practice, interpret the errors in those practices, and evaluate professional development options to meet the improvement needs. The theory in action of Principal A led to the conclusion that a sustainable, long term, externally facilitated program of mathematics professional development met the needs of School A. To counteract the influence of context, assumptions and values when considering the selection, description, interpretation and evaluation 'rungs', Principal A used Anderson's (2004) interactive model as a means to facilitate accessibility and communication, culminating in the inclusion of many individuals and the aggregation of various points of view to inform



effective decision making. Principal A established the school as a learning system with a learning culture.

Principal B examined only student achievement data, based on one test, from the pool of available data and jumped straight to the top Argyris' (1994) ladder by concluding that professional development in mathematics was not a strategic need and that teachers were effective mathematics educators. They chose not to engage in teacher discourse to inquire into the teachers' feelings of capability or effectiveness and nor did they organise classroom visits. The divergence occurred at the very first rung of Argyris' ladder, selection. In addition, Principal B failed to communicate with the teaching community, believing their own claims about school needs to be factual.

#### ***6.4.3 Personal choice versus strategic goals in professional development***

Evidence from the survey and interviews showed that School A had a school-wide, strategically focused, professional development plan for mathematics. School B teachers chose their own professional development activities based on personal choice. School A's method was based on the value attributed to mathematics by the school leadership, the school's strategic needs, and influences from external sources such as Ministry of Education initiatives. Statements made by Principal A showed that the needs of individual teachers were taken into account but were considered against identified weaknesses prior to professional development goals being established. At School B, there was no strategic goal with regards to professional development and leadership identified no need for a focus on mathematics, as explained in the previous section. The main professional development program within the School was a coaching program. The choice of goals set as part of the coaching was left to the individual teacher. However, teachers with mathematics anxiety will respond with avoidance to involvement in mathematics professional development, as highlighted by

Richardson and Suinn (1972), thereby choosing a different professional development activity to mathematics if given the choice.

School B's teachers felt that the professional development provided for mathematics was inadequate, as demonstrated in the comment by a teacher that they did not think the school was helping people who did not have strength in mathematics. Principal B considered their approach to professional development as being personalised but the teachers did not feel qualified enough, in some instances, to allow them to assist their students to become more able in mathematics, i.e., the teacher's mathematical identity was not addressed and remained low. Principal B was unaware of the teachers' feelings, as they had not included this in their selection of data to be evaluated.

School A's professional development plan would be classified as the holistic approach, a planned approach making the best use of strategic resources whereby teachers identify the type of professional development they need within the parameters of the strategic goals of the school, i.e., in School A's case, mathematics. The ongoing concentration of professional development towards mathematics ensured that the teachers at School A complied with Darling-Hammond and Richardson's (2009) research that the largest effects come from programs offering 30 to 100 hours spread out over 6 to 12 months. School A's professional development program was delivered through several different means so that as many participants as possible could be influenced, as recommended by Lauro (1995).

Alternatively, School B's smorgasbord approach to professional development, with its encouragement of subjective, individual choice, an absence of strategic intent, and a lack of connection between evaluation of performance and the professional development activities chosen (Cardno, 1992) meant that, according to teacher statements, each teacher received less than 14 hours of professional development in mathematics, the level at

which Darling-Hammond and Richardson (2009) stated that there would be no effect on teacher learning.

Schmoker (2001) identified that large improvements in student learning can only be achieved through continuous, structured teacher collaboration. This collaboration allows discussion and reflection from which the teachers can make connections about their knowledge. Professional development structures that explicitly encourage collaboration include the professional learning group approach, study groups, and mentoring and coaching programs that provide collaborative opportunities. At School A the role of professional learning group was attributed to the mathematics curriculum team, with the Principal as a participant. This team mentored and coached the other staff members whilst staff meetings allowed study groups. The focused and widespread mathematical professional development at School A meant that the school's teaching community was involved in a structured and continuous programme that allowed the Principal to work alongside the teachers, the teachers to collaborate with each other, and external facilitators to add research-based best practice. Research by Timperley and Robinson (2001) shows that interaction between teachers and external facilitators allows research to become part of a teacher's everyday practice and helps with data analysis and an appreciation of alternatives. Schmoker (2001) agrees that professional development and research should go together for programs to be effective. School B's professional development in mathematics did not involve external facilitators.

## **6.5 The mathematical identity of teachers**

40% of the teachers at School A and 38.5% of the teachers at School B were educated at primary school under the constructivist-based mathematics curriculum introduced in 1992. In addition, 30% of teachers at School A and 30.7% of teachers at School B had 18 or more years experience, which indicates that they would have undergone teacher education prior to constructivism being introduced as the preferred

pedagogical model. The similarities between the percentage of teachers who were either educated at school or on teacher education programs in the constructivist paradigm would appear to eliminate any bias caused by dissimilar educational backgrounds and, yet, teachers at School A benefited from stronger mathematical identities than teachers at School B. In spite of Hembree's research (1990) that showed that pre-service primary teachers had higher levels of mathematics anxiety than students of any other degree, and Carroll's (2005) evidence that more than 50% of Australian teachers have negative feelings about mathematics, only 0% to 10% of School A teachers indicated any negative feelings towards mathematics or anxiety for any of the 19 indicators (Figures 4.3 and 4.4). This contrasted sharply with School B's teachers where between 4% and 28% indicated negative feelings towards mathematics or anxiety. This is even more striking considering that a greater percentage of the teachers at School B, in comparison with School A, completed mathematics-based papers as part of undergraduate studies. As Askew and his colleagues (1997) suggest, the low value held for mathematics and the mathematics anxiety displayed at School B may impact on the ability of teachers to teach mathematics effectively.

Evidence from the focus group interviews at School A indicated that a new member of staff was routinely inducted into a 'catch-up' program of professional development in mathematics. Hence, those with a weak mathematical identity started to address that identity immediately upon joining the school. The existing School A teachers who reflected on themselves as having suffered from a less developed mathematical identity as school students, stated that the focused approach of their school towards mathematics professional development gave them stronger content and pedagogical knowledge. As identified by Lindstrom and Speck (2004) and Alton-Lee and colleagues (forthcoming), teachers need to explore new techniques, implement them, be provided with support and coaching, and then share and reflect with other teachers and, ideally, external facilitators. The fact that the entire school participated in mathematics professional development encouraged such sharing and reflection and this strengthened

their self-belief and mathematical identity, which, they believed, led to having a stronger effect on student achievement.

In contrast to School A, School B teachers had less developed mathematical identities and demonstrated having more negative feelings for mathematics and a greater overall mathematical anxiety. As Tobias (2008) tells us, mathematics anxiety can cause one to forget and lose one's self-confidence and this could lead to a further declining mathematical identity. Some School B teachers stated that they lacked confidence in teaching mathematics and perceived that some of their colleagues did not have the mathematical content knowledge required to teach at the developmental level expected of the senior primary students but, in spite of this, a need for teachers to participate in mathematics professional development was not identified.

The disparate choices of professional development activities, made by the teachers at School B, gave little opportunity for teacher study groups or professional learning communities in any particular area. Research shows that there is a link between improving mathematical identity through engagement with professional development activities (e.g., Schifter (1996) and Millett and colleagues (2007)). By engaging in specific professional development with colleagues, a teacher is able to distance themselves from their multiplicity of professional identities and focus on their mathematical identity as they become aware of and reflect upon their mathematical classroom practice and pedagogy. This allows reconstruction of knowledge and, through active reflection, of mathematical identity. The lack of targeted professional development opportunities to meet the professional needs of teachers in School B indicated that the mathematical identities of School B's teachers were being neglected.

## **6.6 The influence of the Principal on the mathematical identity of teachers**

As this study has shown, Principal A positively influenced the mathematical identity of their teachers through the promotion of a formally structured, long-term professional development plan based on mathematics and the Numeracy Project. The personal involvement of Principal A as a lead learner set expectations and modelled enthusiasm and passion for the teachers to observe. Direct participation allowed interactive reciprocity of communication and accessibility between the Principal, the mathematics curriculum team, and the other members of staff. The professional development offered at School A addressed cognitive ability and a sense of achievement, as evidenced in teacher statements. The professional development also provided study support aimed at improving teacher self-perception of knowledge, ability, and motivation with reduced anxiety. The Principal's direct personal involvement, where they asked questions to deepen their own understanding and encourage others to seek clarification, demonstrated to the teachers that a weak mathematical identity may be improved by critical evaluation and the kind of deep reflection that prolonged mathematics professional development offers teachers.

The teachers from School B expressed concern that there was no educational leadership of mathematics as a curriculum area and that there was a lack of professional development offered to improve their ability. Subsequently, the mathematical identity of teachers at School B suffered and they exhibited lower value perceptions of mathematics and higher levels of mathematical anxiety than the teachers at School A. The absence of professional development to address mathematical identity through improvements in content knowledge and classroom practice was a cause of concern for School B's teachers. Once again, the use of Argyris' (1994) ladder of inference enables a means of linking the failure of Principal B to identify the need for such professional development to the error in selecting

limited data, from the pool of available data, from which to identify and interpret the needs of the teacher.

## **6.7 The role of consistent reflection**

Professional growth cannot be sustained through practice alone. Ongoing inquiry, practice, and reflection to inform practice are critical and must be integrated into daily classroom practice for student achievement to be improved. The ability to study, act, and inform practice provides a spotlight on teaching and learning issues (Lindstrom and Speck, 2004).

The collaborative and discursive aspect of the professional development in mathematics provided at School A encouraged the Principal, the lead teacher of mathematics and the curriculum team, and other teachers to reflect as part of normal routine and practice. Both formal meetings with identified agendas and informal conversations with colleagues embedded professional development as part of normal routine at School A. Darling-Hammond (1994) showed that reflection within a team forced educators to be both learner and teacher whilst the ongoing nature of the professional development in mathematics at School A meant that feedback relating to teaching practice was prompt, as described by Little (2003).

In terms of mathematics, Principal B's reflection process may have derived from a false perception of the teaching team's mathematical ability on the basis of the test results and his or her own strong mathematical identity. However, evidence from the focus group interview at School B shows that the Principal's trust of the teachers was unwarranted. The lack of consistent reflection at School B led to an inefficient team of teachers with regards to mathematics and no improvement of teachers' mathematical identity.

This study suggests that the use of Argyris' (1994) ladder of inference is an extremely useful tool upon which to model the reflective process but any

model could be considered that could bring clarity and consistency to the decision making process.

## **6.8 Reflections on the Psychoanalytical Approach**

Feelings affect our choices but what lies behind our feelings is often a mystery. Walshaw (2010b) emphasises that learners' relationships with mathematics are amongst the most complex and challenging issues facing teachers and researchers today. The reason for using the psychoanalytical approach was that it is precisely the approach that seeks to understand the mystery of our feelings and how they affect and interfere with our actions or desires. Psychoanalysis is a theory of hidden meanings based on early life experience and feelings that stem from that time. However, the approach is not yet commonly used in mathematics education as it is associated with therapy of malfunction and, as it deals with the unconscious, is not easily observed or tested.

Drawing on a well-developed field, such as psychoanalysis, in order to explore a completely different field, is very difficult because I, as researcher, do not have the level of understanding of the complexities of meaning making as a psychoanalyst. Neither am I experienced enough in psychoanalysis to get deep into the meaning making of the analysed, i.e. the Principals and teachers in this research. However, Lacan's ideas give a perspective on what it might mean, affectively, for teachers and school leaders to engage in mathematical pedagogy and leadership of, and participation, in professional development in mathematics. Lacanian ideas also give some insight into how influences might play a part in shaping their identity as generalist teachers delivering mathematics curriculum, and as educational leaders of school efforts towards student achievement.

The case studies, chosen to contrast with each other, show the participants' subjectivities being expressed in both espoused theories and theories in action (Argyris, 1992). The subjectivities cover a range of continua: in



control/out-of-control, emotionally neutral/emotional lauded, connection with others/disconnection from others, and positive identity/negative identity. I suggest that the languages of mathematics and educational leadership carry a wealth of hidden meanings relating to identity, expectation, power, authority, and influence, and that the distortions caused by the languages upon Lacan's three selves may be witnessed in this research.

## **6.9 Limitations**

This research contributes new perspectives and knowledge to the discipline on a range of levels. However, any research has its limitations. The findings of this research are based on a small sample of teachers and two Principals, in one urban area of a city. It is contextual to points of view and the themes that emerge are descriptive. Subsequently, generalisation of the findings for school leaders and teachers in different schools around New Zealand may be limited. However, consideration of the need to constantly address mathematical identity, both of the leader and the classroom practitioner, will cause reflection on current practice for most Principals. In addition, the consideration of what makes effective professional development and mathematics should also be encouraged. I encourage others to trial a similar study.

Because of the complex nature of schools, mathematical pedagogy, and the provision of professional development to affect classroom practice, interpretation of the results in this research can only provide an emerging understanding of the influence of a leader's identity on the provision of professional development in mathematics. The findings are based on one interpretation of data from surveys, voice recordings from focus group meetings, and interviews. Other interpretations are possible, although the interpretations made in this study are strengthened by triangulation and the use of a grounded approach for confirmation of evidence or otherwise.

As discussed in section 3.3, the dilemma of generalisation, researchers themselves bring limitations of their own to a research project (McManus, 2010) in the form of different beliefs, values, assumptions and perspectives from the research subjects and from other researchers. The need for reflexivity over the research process, as explained by Tolich & Davidson (1999), is something I have strived for but cannot objectively measure by definition.

### **6.10 Implications**

This study has highlighted a number of issues for the professional development of Principals and teachers in the field of mathematics. There are also issues in the use of various types of professional development activities for various purposes and how Principals understand the benefits of the various types of activity. Finally, there are implications regarding how Principals identify the professional development needs of their teachers in order to facilitate effective classroom practice improvement in mathematics. The following list of implications highlight the main issues identified by this study:

- ❖ As primary sector teachers have a higher anxiety towards mathematics than any other curriculum area, addressing the teachers' mathematical identity through sustained professional development should be a priority in all primary sector schools. Alternating mathematics professional development each year with other areas identified as requiring development would enable sustained improvement in practice across the main curriculum areas.
- ❖ Principals need to be aware that they require personal mathematical professional development in order to attend to their mathematical identity and to be able to make effective decisions concerning effective classroom practice in mathematics teaching and learning. This is particularly relevant to Principals educated at school prior to

1992 and that have not addressed and practiced constructive pedagogy in mathematics.

- ❖ Evidence within this study suggests that it is the responsibility of the Principal to attend to quality professional development, and to interact in the design process, if consistently high quality mathematical practice is to be attained in classrooms within their schools. Such a result will only be achieved through taking an interactive position in leadership reciprocity (Anderson, 2004) and not by arm's-length management of resource provision. Principals should reflect on the difference between distributive leadership and exclusion of themselves from areas in which they should be involved and informed.
- ❖ Possibilities for reflection on strategic leadership of mathematics by a Principal are suggested by this study. Principals should be able to reflect upon and identify their preferred model of leadership reciprocity (Anderson, 2004) and understand the implications of that model. They should also be aware of, and utilise, the ladder of inference (Argyris, 1994) for both personal reflection and to identify the theories in action of the people with whom they interact in order to build relational trust, improve performance, or identify where conflict may have arisen.
- ❖ Principals need to understand the benefits of 'standing alongside' their teachers as they undertake professional development in mathematics. By participating in the same professional development as their teachers, the Principal is learning the same content at the same rate as the teachers and gets the opportunity to be identified by their team as the lead learner. They will be able to role model discourse and questioning. They may also gain the information required to identify where capacity lies or is absent in mathematics.
- ❖ Data analysis alone is not to be used for the identification of professional development needs. The most important aspects for student achievement in mathematics are the teacher's and the students' relationship to and with mathematics. Analysis of student

data is important but needs to be balanced by classroom visits, discourse, and teacher self-reflection.

- ❖ It is suggested that the core curriculum area of mathematics should be developed through sustained and formalised professional development as it has been shown that teachers with weak mathematical identities will avoid professional development in mathematics if they have the choice. The smorgasbord approach does not address sustained improvement in mathematics.
- ❖ The professional development required for sustainable improvement in classroom practice in mathematics should be over 30 hours to 100 hours long spread out over 6 to 12 months. An external facilitator should be involved as they can apply research based background knowledge and deepen reflection on the learning and the implementation of professional development learning.
- ❖ One-off workshops and one-off staff meetings used for professional development are most suited to the passing of information and not to improvement of classroom practice. If staff meetings are used as professional development opportunities, the theme of learning must be consistent and designed to achieve the minimum recommendation of 30 hours over 12 months for sustainable professional development.
- ❖ Personalised professional development must be identified by gathering data about the teachers' needs from a range of assessments and not purely by teacher choice. Identification of all available data sources from which to select broadens the opportunity for effective description, interpretation and evaluation.

### **6.11 Further research**

This study opens up as many questions as it has answered. Therefore, it is suggested that the following issues identified from the findings and implication of this study warrant further research:

1. Whilst one case study school exclusively utilised personalised professional development, it was clear that this was detrimental without school goals for prioritising professional development needs. However, research shows good improvements in practice arising from personalised professional development. Research that examines the most effective way of developing a professional development plan that integrates both school and individual needs is warranted.
2. Research is warranted on New Zealand Principals, currently leading schools, which were educated and underwent teacher education prior to the introduction of constructivist pedagogy in mathematics. Assessment of the mathematical identity and educational leadership approach towards mathematics for those who maintain behaviourist pedagogical beliefs could form the first level of research, leading to a comparison with Principals who are immersed in the constructivist pedagogy. A measure of the effect size of identified, contrasting leadership approaches on student achievement in mathematics could follow.
3. Mathematics anxiety has been shown to cause a behavioural response of avoidance towards mathematical professional development. Research on the effect this avoidance has on student achievement in mathematics would be warranted in order to provide guidance to the teachers and their Principals on how to support these teachers in their classroom practice.
4. The case study Principals could not accurately measure the 'expected outcome – actual implementation' gap for professional development activities. Research exploring methods of evaluation of implementation of professional learning following various types of activities would be beneficial and allow schools to target professional development resources towards those that would lead to the most effective outcomes.
5. Research would be beneficial that explored the socio-cultural outcome of using a summative test as a measure of student achievement, which was used as a basis of judgements about teacher effectiveness. This would deepen understanding around high stakes testing. If teachers perceived their feeling of worth in terms of being seen as effective if they improve test scores, research would examine how that might affect the

development of mathematics teaching leading to a broader and deeper understanding in students and the effect on teachers' mathematical identity?

6. Further research is required to establish whether a Principal that fails to attend to improving mathematical identity through ongoing professional development for themselves and their teams have an adverse effect on student achievement.
7. The role of reflection has been emphasised in this study. Research that explored Principals' knowledge about tools for reflection and their use in a school leader's decision making process, would be beneficial for the development of school leadership education programs. Although not included in this study, such research could examine the tendency of successful leaders to adopt single loop learning as opposed to double loop learning (Argyris, 1977).
8. A broader base of research is needed to identify other factors that influence good leadership in mathematics in addition to mathematical identity.

## **6.12 Concluding Thoughts**

This research adds to an aggregation of knowledge about the impact a school leader has upon the teaching practices in a school. The study showed the importance of a sustained, long-term professional development plan for teachers of mathematics and the need for a Principal to be a participant in that professional development alongside the teachers. However, another dimension was added and one that needs careful consideration when identifying a school's professional development needs – the crucial element of a reflexive progression that Principals need to consider for this specific context; that of a Principal as an educational leader working towards improving mathematical practice through the provision of professional development. The model used in this study incorporated the ladder of inference (Argyris, 1994), applied in collaboration with others and

enabled by distributed leadership, as a means of ensuring and evaluating claims of reality in decision making about professional development.

Using this process, a Principal may address their own mathematical identity and build relational trust through participation in the professional development activities. Through the interconnected chains of the process, a Principal's mathematical identity may impact their provision of effective professional development in mathematics education which, when applied in collaboration and with reflection, can positively affect the mathematical identity of teachers.

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# APPENDICES

## Appendix A: Information Letter to Principal

Dear Principal,

I would like to invite you and your staff to participate in a research project that explores 'The Impact of the Mathematical Identity of School Leaders on Professional Development in Mathematics Education'. Over the last five years, I have undertaken study at Massey University towards a Masters of Education. I am interested in how school leaders' backgrounds influence their schools and, more specifically in this research, how it affects the provision of professional development in mathematics.

My research project consists of two surveys; one to be completed by yourself, and the other by selected teachers. Depending on the responses, I may seek your permission to hold a focus group or interviews to add clarity to the findings. Can I ask for your support in completing the attached questionnaire? Can I also ask for your support in encouraging your teaching staff to complete the other questionnaire? The questionnaires take approximately 20 minutes to complete and, if preferred, will be available on [www.surveymonkey.com](http://www.surveymonkey.com).

No one will be asked to give his or her name or the name of the school on the questionnaire. Pseudonyms will be used in the research report so you will not be named. This is to ensure anonymity of both individuals and schools. In addition to this, all data will be aggregated. At the conclusion of this research project, all source data will be destroyed although a summary of findings will be sent to your school for your use.

I hope that you will agree to participate in this research. If I don't hear in advance, I will follow up with a call later in the week to confirm your participation. If you do agree could you please e-mail me on [skjones@xtra.co.nz](mailto:skjones@xtra.co.nz) with the 'intention to participate' form (overleaf), or by faxing it to 09-473-3296. Alternatively, I can come and pick it up. I enclose the questionnaire should you wish to complete it at the same time.

My timeline for the return of the 'intention to participate' form and completed questionnaire is by Thursday, 12<sup>th</sup> August. The questionnaires for your team will be mailed out in week 5, term 3.

If you have any concerns please contact me at home (09) 473-3295, mobile on 021-773-105 or email at the above address. Alternatively, you may wish to contact my supervisor, Dr. Bobbie Hunter, during work hours on (09) 414-0800 ext 9873 (email: [R.Hunter@massey.ac.nz](mailto:R.Hunter@massey.ac.nz)).

Thank you for your time and I hope you choose to be a part of this project.

Yours Sincerely,

Stephen Kendall-Jones

*This research has been designated as a low risk ethics project. Any concerns may be directed to: The Ethics Administrator, Research Ethics Office, Old Main Building, PN221, Massey University, Private Bag 11 222, Palmerston North.*

## Appendix B: Information Letter to Teachers

### **The Impact of a School Leader's Mathematical Identity on Professional Development Provision in Mathematics Education.**

#### **TEACHER INFORMATION SHEET**

My name is Stephen Kendall-Jones and I am currently studying at Massey University for a Masters of Education and am undergoing research focusing on a school leader's personal identity as a mathematician and understanding how this may affect the provision of mathematics-based professional development for teachers. I invite you to participate in this research during Terms 3 and 4 of this year.

In Term 3 (2010) your school Principal agreed to participate in their part of the research and I hope to undertake a complementary part of the project with you.

Mathematical identity refers to a person's self-concept as a mathematician. "How individuals know and name themselves ..., and how an individual is recognized and looked upon by others" (Grootenboer, et al., 2006, p. 612). To investigate the influence this has on professional development provision for teachers, this study will involve teachers at the school who are be invited to participate. The project will involve you as respondents through completion of a survey. There may need to be a later focus group discussion or individual interviews to clarify certain factors. A particular focus will be on the types and effectiveness of the professional development in maths that you receive.

The project is comprised of four phases:

1. Term 3, week 3 and 4: A survey to be completed by your Principal.
2. Term 3, weeks 4 and 5: A survey to be completed by the selected teachers.
3. Term 3 / 4 holidays and Term 4, week 1: Semi-structured interviews with principals.
4. Term 4, weeks 1, 2 and 3: Focus group discussions with the teachers from the various schools involved in the research. Details of times and dates for focus groups will be organised well in advance to eliminate any inconvenience.
5. Term 4, week 8: The principals and researcher, as a group, will further discuss the general findings and reflect on any conclusions to be drawn for use in the school.

**The time involved for the survey will be no more than fifteen minutes and can be carried out online (preferred) or on hard copy.** The questionnaires take approximately 15 minutes to complete and, if preferred, will be available on <http://www.surveymonkey.com/s/mathspd1b>.

All project data will be stored in a secure location, with no public access and used only for this research and any publications arising from this research. After completion of five years, all data pertaining to this study will be destroyed in a secure manner. All efforts will be taken to maximize confidentiality and anonymity for participants. The school name and names of all participants will be assigned pseudonyms to maintain their anonymity. Near the end of the study a summary will be presented to you to verify accuracy, and following any necessary adjustments, a final summary will be provided to the school and teachers involved.

Please note you have the following rights in response to my request for you to participate in this study.

- Decline to answer any particular question;
- As participation involves being part of a school team, withdrawal would need to be discussed with appropriate members of the school management team;
- Ask any questions about the study at any time during participation;
- Provide information on the understanding that your name will not be used unless you give permission to the researcher;
- Be given access to a summary of the project findings when it is concluded.

If you have further questions about this project, you are welcome to discuss them with me personally:

Stephen Kendall-Jones: Massey University (Albany), School of Education. Phone (home): (09) 473-3295. Email. [skjones@xtra.co.nz](mailto:skjones@xtra.co.nz); or contact my supervisor at Massey University (Albany), School of Education; Dr. R. Hunter: (09) 4140800 Extension 9873. Email. [R.Hunter@massey.ac.nz](mailto:R.Hunter@massey.ac.nz) ;

This project has been reviewed and approved by the Massey University Human Ethics Committee, ALB Protocol NO/NO (MUAHEC 06/2010). If you have any concerns about the conduct of this research, please contact Associate Professor Kerry P Chamberlain, Chair, Massey University Campus Human Ethics Committee: Albany, telephone 09 443 9700 x9078, email [K.Chamberlain@massey.ac.nz](mailto:K.Chamberlain@massey.ac.nz).

Yours Sincerely,

Stephen Kendall-Jones



## Appendix C: Intention to Participate



**Massey University**

Te Kunenga ki Pūrehuroa

### **Leadership and Professional Development Questionnaire Intention to Participate**

Please complete the following and fax or e-mail it to the contacts listed.

The teachers at \_\_\_\_\_ (name of school)

**Will / will not** (please circle)

be participating in the leadership and professional development questionnaire.

Does your school wish to receive a copy of the summary of project findings?

**Yes/no**

Who will be the contact person at the school? \_\_\_\_\_

If you would like you to contact me to discuss our concerns concerning this research, please list those concerns below and I shall contact you within two working days:

---

---

---

---

Please fax or e-mail this form to:

Stephen Kendall-Jones,

Massey University,

Fax number: (09) 473-3296

Email: [skjones@xtra.co.nz](mailto:skjones@xtra.co.nz)



## Appendix D: Principals' Questionnaire

### Impact of Mathematical Identity of School Leaders on Professional

#### 1. Introduction

Thank you for agreeing to participate in the completion of this questionnaire. The questionnaire is about professional development leadership for mathematics and should take around twenty minutes.

To ensure anonymity, neither you nor your school will be identified by name or otherwise. At the conclusion of this research project, all source data will be destroyed and you will not be named in any written reports. In addition, all data will be aggregated.

In accordance with the Massey University Ethics Committee requirements, you have the right to:

- Decline to participate
- Refuse to answer any particular question
- Withdraw from the study at any time
- Ask questions about the study at any time during your participation

At the conclusion of this project, a summary of findings from the research will be sent to your school for your use.

Thank you for your time.

Stephen Kendall-Jones

#### 2. About You

##### 1. Gender

☐ Male

☐ Female

##### 2. Age

☐ 25-29

☐ 30-34

☐ 35-39

☐ 40-44

☐ 45-49

☐ 50-54

☐ 55-59

☐ 60-64

☐ 65+

##### 3. Number of years in principal positions

##### 4. Number of years in your current position:

#### 3. Your Maths background

## Impact of Mathematical Identity of School Leaders on Professional

### 5. What is your highest qualification in mathematics?

- ☐ None
- ☐ School certificate
- ☐ University Entrance / 6th Form certificate
- ☐ University Bursary
- ☐ 1st year University
- ☐ 2nd Year University
- ☐ 3rd Year University
- ☐ Masters degree
- ☐ Doctorate

### 6. Have you completed a qualification that includes a mathematics component or mathematics education e.g. B.Sc., M.Ed.? Please name:

### 7. Have you participated in a contract for mathematics in the New Zealand Curriculum?

- ☐ Yes
- ☐ No

### 8. Are you trained in the Numeracy Project?

- ☐ Yes
- ☐ No

### 9. Have you ever held responsibility for the mathematics department (Head of department) in a school?

- ☐ Yes
- ☐ No

## 4. Professional Development

### 10. What is the most common curriculum area in which you have undertaken professional development over the last three years?

## Impact of Mathematical Identity of School Leaders on Professional

**11. Are professional development goals set as part of your annual appraisal?**

☐ Yes

☐ No

**12. If your answer to the question above was yes, did you include maths as a part of the goals?**

☐ Yes

☐ No

**13. During the last TWO years, did you participate in, or lead, any of the following professional development activities related to the teaching of mathematics?**

Approximate Number of Times

Tertiary Study	<input type="text"/>
Study award	<input type="text"/>
Conference or professional association meeting	<input type="text"/>
One Day workshop or training session	<input type="text"/>
Observational visit to another school	<input type="text"/>
Mentoring and/or coaching as part of a formal arrangement	<input type="text"/>
As part of a school cluster group	<input type="text"/>
Professional Learning Group	<input type="text"/>
Individual or collaborative research	<input type="text"/>
Ministry of Education contract	<input type="text"/>
Official group focusing on curriculum, instruction, or student assessment	<input type="text"/>
In-school (as part of staff development)	<input type="text"/>
Consultation with a mathematics specialist	<input type="text"/>
Other	<input type="text"/>

## 5. The Impact of Professional Development on You

## Impact of Mathematical Identity of School Leaders on Professional

**14. Consider all professional development activities in which you participated or lead, to what extent did you learn about each of the following topics?**

	not at all	some learning as part of general PD	small extent	moderate extent	large extent
How students learn mathematics	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mathematics theory or applications	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Curricular materials available in mathematics e.g. texts	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Instructional methods for teaching mathematics	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Effective use of manipulatives in mathematics instruction	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Use of computers or other technology in maths instruction	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Methods for assessing students in mathematics	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Issues related to ability grouping in mathematics	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Teaching mathematics to students of diverse cultures	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**15. How would you rate the impact of YOUR professional development in mathematics on YOU?**

☐ Negative impact
 ☐ No impact
 ☐ Small positive impact
 ☐ Moderate positive impact
 ☐ Large positive impact

**16. How would you rate the impact of YOUR professional development in mathematics on YOUR STAFF?**

☐ Negative impact
 ☐ No impact
 ☐ Small positive impact
 ☐ Moderate positive impact
 ☐ Large positive impact

**17. How would you rate the impact of YOUR professional development in mathematics on your STUDENTS' achievement?**

☐ Negative impact
 ☐ No impact
 ☐ Small positive impact
 ☐ Moderate positive impact
 ☐ Large positive impact

## 6. Effective Professional Development



## Impact of Mathematical Identity of School Leaders on Professional

**18. What do you consider to be the most effective type of professional development in mathematics for YOU?**

- |  |   |
|--|---|
| <input type="checkbox"/> One Day workshop or training session                      | <input type="checkbox"/> Professional Learning Group              |
| <input type="checkbox"/> Conference or professional association meeting            | <input type="checkbox"/> Individual or collaborative research     |
| <input type="checkbox"/> Mentoring and/or coaching as part of a formal arrangement | <input type="checkbox"/> In-school (as part of staff development) |
| <input type="checkbox"/> As part of a school cluster group                         | <input type="checkbox"/> Other                                    |

**19. What do you consider to be the most effective type of professional development in mathematics for YOUR STAFF?**

- |  |   |
|--|---|
| <input type="checkbox"/> One Day workshop or training session                      | <input type="checkbox"/> Professional Learning Group              |
| <input type="checkbox"/> Conference or professional association meeting            | <input type="checkbox"/> Individual or collaborative research     |
| <input type="checkbox"/> Mentoring and/or coaching as part of a formal arrangement | <input type="checkbox"/> In-school (as part of staff development) |
| <input type="checkbox"/> As part of a school cluster group                         | <input type="checkbox"/> Other                                    |

**20. Are there any impediments to your accessing professional development in maths e.g. location, cost, pedagogical reasons?**

## 7. Your thoughts on Mathematics

The next few questions relate to how you think about mathematics. Please rate:

## Impact of Mathematical Identity of School Leaders on Professional

### 21. How do you personally feel towards using Mathematics?

	strongly disagree	mildly disagree	neutral	mildly agree	strongly agree
I find many topics in mathematics to be interesting.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Solving maths problems is interesting for me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mathematics fascinates me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am interested in doing maths problems.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It is fun to do maths.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I find math intellectually stimulating.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
There are almost no benefits from knowing mathematics	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I see no point in being able to do maths.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Having a solid background in mathematics is worthless.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I have little to gain by learning how to do maths.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I do not need maths in my everyday life.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Calculating my school budget is stressful	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Understanding maths has many benefits for me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would be upset to be seen as "average" in maths.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Doing well in courses involving maths is important to me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Maths activities scare me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Trying to do maths causes me a lot of anxiety.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mathematical symbols confuse me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Solving math problems is too difficult for me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

## 8. Leadership of Mathematics

### 22. Where would you describe your leadership type with regards to your school's mathematics implementation?

☐ Full control
 ☐ Mentor
 ☐ Coach
 ☐ Delegate
 ☐ Distributive
 ☐ Facilitative

Any clarification

## Impact of Mathematical Identity of School Leaders on Professional

**23. What reinforcement activities have you put into place to ensure that professional development for your staff is put into action?**

**24. How often would you estimate that you participate in discussions with your staff about their pedagogy in mathematics?**

☐ Seldom

☐ Once a term

☐ Once a month

☐ Once a week

☐ Daily

Thank you very much for taking the time to participate in this research. I very much appreciate that you have done this even with your busy schedule. I will contact you soon about staff involvement.

Please press 'Done' to complete your return. Thank you once again.

Stephen.

Thank you very much for taking the time to participate in this research. I very much appreciate that you have done this even with your busy schedule. I will contact you soon about staff involvement.

Please press 'Done' to complete your return. Thank you once again.

Stephen.

## Appendix E: Teachers' Questionnaire

### Impact of Mathematical Identity of School Leaders on Professional

#### 1. Introduction

Thank you for agreeing to participate in the completion of this questionnaire. The questionnaire is about professional development leadership for mathematics and should take around fifteen minutes.

To ensure anonymity, neither you nor your school will be identified by name or otherwise. At the conclusion of this research project, all source data will be destroyed and you will not be named in any written reports. In addition, all data will be aggregated.

In accordance with the Massey University Ethics Committee requirements, you have the right to:

- Decline to participate
- Refuse to answer any particular question
- Withdraw from the study at any time
- Ask questions about the study at any time during your participation

At the conclusion of this project, a summary of findings from the research will be sent to your school for your use.

Thank you for your time.

Stephen Kendall-Jones

#### 2. About You

##### 1. Gender

- ☐ Male
- ☐ Female

##### 2. Age

- ☐ under 25
- ☐ 25-29
- ☐ 30-34
- ☐ 35-39
- ☐ 40-44
- ☐ 45-49
- ☐ 50-54
- ☐ 55-59
- ☐ 60-64
- ☐ 65+

##### 3. Number of years teaching experience

##### 4. Number of years in your current position:

##### 5. Current position:

- ☐ Head of Maths      ☐ Team Leader      ☐ Senior teacher      ☐ Class teacher



## Impact of Mathematical Identity of School Leaders on Professional

**6. Have you ever been Head of Department for Mathematics in a school?**

- ☐ Yes  
☐ No

### 3. Your Maths background

**7. What is your highest qualification in mathematics?**

- ☐ None  
☐ School certificate  
☐ University Entrance / 6th Form certificate  
☐ University Bursary  
☐ 1st year University  
☐ 2nd Year University  
☐ 3rd Year University  
☐ Masters degree  
☐ Doctorate

**8. Have you completed a qualification that includes a mathematics component or mathematics education e.g. B.Sc., M.Ed.? Please name:**

**9. Have you participated in a contract for mathematics in the New Zealand Curriculum?**

- ☐ Yes  
☐ No

**10. Are you trained in the Numeracy Project?**

- ☐ Yes  
☐ No

### 4. How you feel about Mathematics

## Impact of Mathematical Identity of School Leaders on Professional

### 11. How do you personally feel towards using Mathematics?

	strongly disagree	mildly disagree	neutral	mildly agree	strongly agree
I find many topics in mathematics to be interesting.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Solving maths problems is interesting for me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mathematics fascinates me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am interested in doing maths problems.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It is fun to do maths.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I find math intellectually stimulating.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
There are almost no benefits from knowing mathematics	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I see no point in being able to do maths.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Having a solid background in mathematics is worthless.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I have little to gain by learning how to do maths.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I do not need maths in my everyday life.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Calculating my school budget is stressful	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Understanding maths has many benefits for me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would be upset to be seen as "average" in maths.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Doing well in courses involving maths is important to me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Maths activities scare me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Trying to do maths causes me a lot of anxiety.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mathematical symbols confuse me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Solving math problems is too difficult for me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

## 5. Overall Professional Development

**12. What is the ONE most common curriculum area in which you have undertaken professional development over the last three years?**

**13. Are you part of an appraisal system in your school?**

☐ Yes

☐ No

## Impact of Mathematical Identity of School Leaders on Professional

**14. Are professional development goals set as part of your annual appraisal?**

☐ Yes

☐ No

**15. If your answer to the question above was yes, did you include maths as a part of the goals?**

☐ Yes

☐ No

## 6. Mathematics Professional Development

**16. During the last THREE years, did you participate in any of the following professional development activities related to the teaching of mathematics?**

	Approximate Number of Times	Internal or External Provider
Tertiary Study	<input type="text"/>	<input type="text"/>
Study award	<input type="text"/>	<input type="text"/>
Conference or professional association meeting	<input type="text"/>	<input type="text"/>
One Day workshop or training session	<input type="text"/>	<input type="text"/>
Observational visit to another school	<input type="text"/>	<input type="text"/>
Mentoring and/or coaching as part of a formal arrangement	<input type="text"/>	<input type="text"/>
As part of a school cluster group	<input type="text"/>	<input type="text"/>
Professional Learning Group	<input type="text"/>	<input type="text"/>
Individual or collaborative research	<input type="text"/>	<input type="text"/>
Ministry of Education contract	<input type="text"/>	<input type="text"/>
Official group focusing on curriculum, instruction, or student assessment	<input type="text"/>	<input type="text"/>
In-school (as part of staff development)	<input type="text"/>	<input type="text"/>
Consultation with a mathematics specialist	<input type="text"/>	<input type="text"/>
Other	<input type="text"/>	<input type="text"/>

## 7. The Impact of Professional Development on You

## Impact of Mathematical Identity of School Leaders on Professional

**17. Consider all professional development activities in which you participated or lead, to what extent did you learn about each of the following topics?**

	not at all	some learning as part of general PD	small extent	moderate extent	large extent
How students learn mathematics	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mathematics theory or applications	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Curricular materials available in mathematics e.g. texts	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Instructional methods for teaching mathematics	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Effective use of manipulatives in mathematics instruction	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Use of computers or other technology in maths instruction	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Methods for assessing students in mathematics	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Issues related to ability grouping in mathematics	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Teaching mathematics to students of diverse cultures	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**18. How would you rate the impact of YOUR professional development in mathematics on YOU?**

☐ Negative impact
 ☐ No impact
 ☐ Small positive impact
 ☐ Moderate positive impact
 ☐ Large positive impact

**19. How would you rate the impact of YOUR professional development in mathematics on your STUDENTS' achievement?**

☐ Negative impact
 ☐ No impact
 ☐ Small positive impact
 ☐ Moderate positive impact
 ☐ Large positive impact

**20. What do you consider to be the most effective type of professional development in mathematics for YOU?**

<input type="checkbox"/> One Day workshop or training session	<input type="checkbox"/> Professional Learning Group
<input type="checkbox"/> Conference or professional association meeting	<input type="checkbox"/> Individual or collaborative research
<input type="checkbox"/> Mentoring and/or coaching as part of a formal arrangement	<input type="checkbox"/> In-school (as part of staff development)
<input type="checkbox"/> As part of a school cluster group	<input type="checkbox"/> Other

**8. Your perception of your Principal's participation in professional developme...**



## Impact of Mathematical Identity of School Leaders on Professional

**21. How often do you BELIEVE your Principal PARTICIPATES in professional development specifically in Mathematics?**

- ☐ Never      ☐ Infrequently (less than once a year)      ☐ Occasionally (once a year)      ☐ Frequently (twice a year)      ☐ Consistently (more than twice a year)

**22. How well does your principal promote YOUR access to Mathematics professional development?**

- ☐ Not at all  
☐ A little  
☐ Moderately  
☐ Well  
☐ Extremely well

**23. How often would you estimate that you participate in discussions with your principal about pedagogy in mathematics?**

- ☐ Seldom      ☐ Once a term      ☐ Once a month      ☐ Once a week      ☐ Daily

**24. Where would you describe your principal's leadership with regards to your school's mathematics implementation?**

- ☐ Full control      ☐ Mentor      ☐ Coach      ☐ Delegate      ☐ Distributive      ☐ Facilitative

Any clarification

**25. Does your principal put follow-up (reinforcement) activities into place to ensure that the learning from professional development is put into action?**

- ☐ Never  
☐ Sometimes  
☐ Often  
☐ Always

## Impact of Mathematical Identity of School Leaders on Professional

**26. How would you rate the amount of professional development in Mathematics that you receive?**

- ☐ I do not receive any Maths PD
- ☐ I get PD but need more to MAINTAIN my Maths teaching skills
- ☐ I get enough PD to MAINTAIN my Maths teaching skills
- ☐ I get enough PD to IMPROVE my Maths teaching for a short time
- ☐ I get enough PD to IMPROVE my Maths teaching for a long time (sustainable)

**27. Overall, how well do you believe that your principal LEADS professional development in Mathematics?**

- ☐ There is no leadership in Maths PD
- ☐ Someone else in the school leads Maths PD without principal involvement
- ☐ Principal leads indirectly (through someone else)
- ☐ Principal leads directly with limited results
- ☐ Principal leads directly with strong results

Thank you very much for taking the time to participate in this research. I very much appreciate that you have done this even with your busy schedule. I will contact you soon about staff involvement.

Please press 'Done' to complete your return. Thank you once again.

Stephen.

## **Appendix F: Letter Inviting Principal to Follow-Up Interview**

5<sup>th</sup> October 2010

Dear Principal,

Recently you, as Principal, and staff at your school completed questionnaires relating to my research project about the way that a school leader's mathematical identity may influence the provision of professional development in mathematics. You may remember that this research is part of my study at Massey University towards a Masters of Education.

To further my research I need to obtain more purposeful and detailed information and I would like to invite you to be interviewed at a time convenient to you. I am more than willing to come to your school. The interview is expected to take around 20 - 30 minutes only.

Yours will be one interview amongst others with principals from other schools. The interviews will form the basis of case studies from the principal's perspective and will be digitally recorded (with your permission) for subsequent transcription and analysis. The contents of the tapes will be confidential to my supervisor and me. You may decline to answer a question or may ask for the recorder to be switched off at any time. The recordings will be held securely and destroyed or deleted after the required time. Any written reports will not identify you, or your school, by name.

I attach an information sheet with the proposed questions for the interview. You may wish to discuss other issues related to mathematical identity, education and professional development.

Unless you are available earlier, I shall follow up this request in two weeks to establish if you are able to take part in these interviews. If you have any queries about the questionnaire or wish to obtain further information about the project, I can be contacted on 021-773-105 (mobile), at home in the evenings on (09) 473-3295, or by e-mail at [skjones@xtra.co.nz](mailto:skjones@xtra.co.nz).

Thank you once again for your time.

Yours Sincerely,

*Stephen Kendall-Jones*

Stephen Kendall-Jones

### **Areas for Further Development through Interview**

Below are the starter questions for the discussions. You may wish to add other areas at the time. In accordance with the Massey University Ethics Committee requirements, you have the right to:

- Decline to participate
- Refuse to answer any particular question
- Withdraw from the study at any time
- Ask questions about the study at any time during your participation

### **Focus Questions for Discussion**

1. How do you identify overall professional development needs for your school?
2. On what basis do you allocate resources (of people, time and finance) towards professional development?
3. What priority do you give towards providing professional development in mathematics compared to other areas of the curriculum?
4. What would be the ideal professional development programme for your school to improve effective practice in mathematical education?
5. Do you think mathematics professional development should be part of a principal's appraisal? Why/ why not?
6. How do you perceive yourself to be as a mathematician?
7. How important do you believe it is that you are the 'lead learner' for mathematics in your school?
8. When discussing maths with your staff, what would you normally cover?



## **Appendix G: Focus Group Interview Consent Form**

### **‘The Impact of the Mathematical Identity of School Leaders on Professional Development in Mathematics Education’**

#### **Focus Group Consent Form**

**This consent form shall be kept for a period of five (5) years**

I have read the information sheet and have had details of the study explained to me. My questions have been answered to my satisfaction and I understand that I have the right to:

- Decline to participate
- Refuse to answer any particular question
- Withdraw from the study at any time
- Ask questions about the study at any time during your participation

I agree to participate in this study under the conditions set out in the information sheet.

I agree to provide information to the researcher on the understanding that my name will not be used without my permission.

I agree to the interview being recorded with the understanding that, at any time during the focus group interview, I can ask for all or some of my comments to be removed from the transcript.

I agree to keep the content and identities of other participants in the focus group confidential.

**FULL NAME:** \_\_\_\_\_

**SCHOOL:** \_\_\_\_\_

**SIGNED:** \_\_\_\_\_

**DATE:** \_\_\_\_\_

## **Appendix H: Focus Group Information Sheet**

### **Information Sheet for Teachers' Focus Groups**

#### **'The Impact of the Mathematical Identity of School Leaders on Professional Development in Mathematics Education'**

During the last two terms your school was involved in completing questionnaires for my research about the way that leaders' backgrounds may influence the provision of professional development in mathematics. To further my research I need to include case studies and the focus groups will form the basis of these.

Below are the starter questions for the discussions. You may wish to add other areas at the time. In accordance with the Massey University Ethics Committee requirements, you have the right to:

- Decline to participate
- Refuse to answer any particular question
- Withdraw from the study at any time
- Ask questions about the study at any time during your participation

Interviews will be recorded on a voice recorder with the permission on the interviewees. I shall transcribe the interviews personally. The contents of the tapes will be confidential to my supervisor and me. The recordings will be held securely and destroyed or deleted at the end of the required time for this research. Any written reports will not identify you or your school by name.

#### **Focus Questions for Discussion**

1. What is the nature of your principal's involvement in mathematics at your school?
2. How do you feel your needs for professional development in mathematics are met at your school?
3. On what basis do you believe your principal allocates resources (people, time and finance) towards professional development in mathematics?
4. What priority do you think the principal gives towards providing professional development in mathematics compared to other areas of the curriculum?
5. What would be the ideal professional development programme for your school to improve effective practice in mathematical education?
6. How do you perceive your principal to be as a mathematician?
7. How important do you believe it is that a principal is the 'lead learner' for mathematics in your school?