An Investigation of the Ways in Which School Mathematics Leaders Support Primary Teachers' Professional Learning

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Abstract

School Mathematics Leaders hold key responsibilities for improving mathematics teaching and learning in primary schools. Many factors influence improved learning outcomes of students in mathematics, including teachers, school leadership, curriculum planning and in particular School Mathematics Leaders. The aim of this study was to understand the ways in which School Mathematics Leaders supported teachers to continue to learn to teach mathematics.

Continued professional learning is important if teachers are to improve their practice in order to help students succeed in mathematics. It is recognised that for effective mathematics teaching to occur, teachers must know the mathematical content and know how to teach it. This research investigated the critical role that School Mathematics Leaders played in supporting classroom teachers to extend their knowledge and skills for teaching mathematics by facilitating and encouraging teacher professional growth.

Teacher learning and leadership informed the theoretical standpoint of this study. Data collection and analysis occurred in two phases. Phase 1 was a survey of 56 School Mathematics Leaders. The survey was implemented as a means of gathering data about individual School Mathematics Leaders, and as a result supported the selection of participants for the case studies. The survey was also used to gain an overall picture of the current nature of the School Mathematics Leader role and enabled the researcher to obtain a sense of how School Mathematics Leaders perceived the challenges and successes of mathematics leadership. Phase 2, the case studies, involved four School Mathematics Leaders who were observed, videod and interviewed over a ten month period as a means of providing a rich, detailed description of mathematics leadership and evidence of ways in which the leaders supported teachers to learn. A qualitative case study using open coding procedures was selected as the most suited research method to ensure the research questions were answered and the purpose of the study was achieved.

The key finding which emerged was the importance of the School Mathematics Leaders supporting teacher professional learning in collaboartive teams during planning and professional learning team meetings. Further findings indicated that teacher learning was supported as School Mathematics Leaders built constructive relationships with teachers and principals and engaged in ongoing profesional learning. It also became evident that teacher learning was supported in the classroom when teaching mathematics lessons alongside a

School Mathematics Leader. These findings informed a list of identifiable actions that were demonstrated by effective School Mathematics Leaders such as building relationships and facilitating regular team planning.

A number of important insights were identified as a result of this study, including: the need for School Mathematics Leaders to have adequate time allocated to lead mathematics; the support of the school principal; and personal professional development as leaders. The professional support provided by School Mathematics Leaders encourages teachers to grow their mathematical knowledge for teaching through learning in practice. In the long term it is hoped that more knowledgeable and skilled teachers will lead to improved student learning outcomes in mathematics.

Declaration

This thesis is an original work of my research and contains no material which has been accepted for the award of any other degree or diploma at any university or equivalent institution and that, to the best of my knowledge and belief, this thesis contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

Signature:

Kerryn Driscoll

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Publications During Enrolment

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Developing an interest in mathematics education was never something that I ever imagined I would do. However, quite a few years ago at a conference I was inspired as I listened to Emeritus Professor Doug Clarke speak about the work his team were doing in the Early Numeracy Research Project. Teaching mathematics took on a whole new meaning and my enthusiam for learning more about mathematics began.

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List of Abbreviations

AAMT	Australian Association of Mathematics Teachers
ACARA	Australian Curriculum, Assessment and Reporting Authority
AITSL	Australian Institute of Teaching and School Leadership
AMSI	Australian Mathematical Sciences Institute
COAG	Council of Australian Governments
DEECD	Department of Education and Early Childhood Development Victoria)
DET	Department of Education and Training (Victoria)
ENRP	Early Numeracy Research Project
ILNNP	Improving Literacy and Numeracy National Partnership
MCEETYA	Melbourne Declaration on Educational Goals for Young Australians
MCK	mathematical content knowledge
MKT	mathematical knowledge for teaching
NAPLAN	National Assessment Program – Literacy and Numeracy
PCK	pedagogical content knowledge
PD	professional development
PISA	Programme for International Student Assessment
PL	professional learning
PMS	Primary Mathematics Specialists
PMSS	Primary Mathematics Science Specialists
RMIT	Royal Melbourne Institute of Technology
TIMSS	Trends in International Mathematics and Science Study

Chapter 1: Introduction

This introductory chapter includes a brief overview of the importance of this study and the need for mathematics leaders in primary schools. A broad context of the study is outlined, along with a description of initiatives undertaken in teacher professional development in mathematics education over the past decade, in the state of Victoria, Australia. The term *School Mathematics Leader* is defined. Next, the problem to be addressed is outlined, together with the purpose and aims of the study, the research questions, and my personal motivation. Finally, an overview of the thesis is provided.

1.1 The Importance of the Study

Urgent action is needed to improve Australia's performance in mathematics education. Not only is improvement in mathematics education a key challenge in Australian schools, but also a priority for the future success of our country. While principals have a critical role to play in building the culture in schools to improve overall student achievement, it is teachers with expertise in teaching mathematics that make a difference to students' mathematical experiences. Building teacher pedagogical expertise requires ongoing professional learning. Therefore, creating conditions for teachers to engage in quality professional learning is essential, which leads to the significance of this study. Potentially through their actions, teachers with the responsibility for leading mathematics, that is the School Mathematics Leaders, can support their teacher colleagues with quality professional learning.

This thesis reports on the critical role that primary School Mathematics Leaders play in supporting classroom teachers when facilitating and encouraging teacher professional growth, as they build professional learning communities. In the context of this study, professional learning communities are defined as "a group of professionals who focus on learning within a supportive, self-centred community" (InPraxis Group, 2006). The results of this study will contribute to and extend the current literature on mathematics leadership in primary schools. Although the School Mathematics Leader role is common in primary schools, a review of the literature confirms a paucity in research related to mathematics leadership, particularly the ways in which School Mathematics Leaders support teacher learning.

1.2 The Context of the Study

The study occurred at a time when primary and secondary students' mathematical results nation-wide were seen as a concern, according to the Program for International Students Assessment [PISA] (ACER, 2019). Also, as the number of students choosing to continue to study mathematics declines in secondary schools, there is a sense of urgency to increase investment, time, and effort, into improving mathematics teaching and learning (Australian Mathematical Sciences Institute [AMSI], 2017, 2019; Council of Australian Governments [COAG], 2008). Improved performance in mathematics is a priority and a challenge, not only for Victorian schools, but also for schools across Australia. Sullivan (2011) pointed out that although some Australian students are doing well in mathematics there are others who appear to be "unprepared for the demands of mathematics study in the later secondary years". Sullivan (2011) pointed out that while some students in Australian schools are doing well in mathematics, there are others who appear unprepared for the study demands of mathematics in their later secondary years which has implications for initiatives related to teacher learning and teaching practices used in schools.

The latest Trends in International Mathematics and Science Study [TIMSS] results of Australian Year 4 and Year 8 students have basically remained the same between 2011 and 2015. Of concern is the fact that the gap between the world's highest performing countries and Australia is widening (Australian Council for Educational Research [ACER], 2016). The PISA results, in 2012, show that Australian students performed well in mathematical literacy assessment, and scored significantly higher than the Organisation for Economic Co-operation and Development [OECD] average. "The OECD average for mathematical literacy has not changed significantly between 2003 and 2012" (ACER, 2013, p. xiii). Nine countries significantly improved their mathematical literacy performance over this time. However, 13 countries (including Australia), declined significantly at each of the percentiles between PISA 2003 and PISA 2012, and this is a major concern. More recent results from PISA 2015, show that Australian students continued to achieve significantly higher than the OECD average, but performed lower than 19 countries, including Canada, Germany, and Finland, with only 55% of Australian students at the National Proficient Standard (ACER, 2017). While in 2018, Australian students for the first time have not scored higher than the OECD average showing a continued decline between 2003 and 2018 (ACER, 2019). Australia's performance was similar to that of New Zealand, France, and Italy, but higher than that of the United States (ACER, 2019).

Although PISA is not a curriculum-based assessment, it does measure how well students are prepared to use their mathematics “knowledge and skills in particular areas to meet real-life opportunities and challenges” (ACER, 2017, p. 1). PISA data provides an insight into students’ capacity to “employ and interpret mathematics in a variety of contexts … including reasoning mathematically and using mathematical concepts, procedures, facts and tools” (ACER, 2017, p. 2). In Australia, PISA is a key part of our assessment program, along with the National Assessment Program—Literacy and Numeracy [NAPLAN], and TIMSS, and represents a “challenging but reasonable expectation of student achievement” (ACER, 2017, p. 13). In summary, these results indicate that improvement in mathematics needs to be a national priority.

1.3 Context and Commonwealth Government Initiatives

Over the past ten years the Australian Government has invested in school-based initiatives that have aimed to improve results in primary and secondary mathematics education. For example, in 2009 all states and territories and the Australian Government agreed through the Council of Australian Governments [COAG], to work together on improving the quality of Australian schooling and student outcomes in an initiative known as the Smarter Schools National Partnerships (Department of Education and Early Childhood Development [DEECD], 2014). This initiative was made up of the Literacy and Numeracy National Partnership, the Low Socio-economic Status School Communities National Partnership, and the Improving Teacher Quality National Partnership (DEECD, 2014). Selection for participation in these partnerships was restricted to schools where there were significant numbers of students performing at or below the national minimum standard in literacy and/or numeracy, or where there was a high Student Family Occupation index (low socio-economic status) (DEECD, 2014). Following this initiative, in 2012 to 2013, the Commonwealth, states and territories then entered into the National Partnership on Improving Literacy and Numeracy [ILNNP] to continue work in this area.

1.4 Context and Victorian Government Initiatives

In 2013 the Victorian Government identified an aim of renewed focus on teacher practice. The focus was on providing schools with evidence-based resources and support to improve professional practice and leadership, whole-school curriculum planning and assessment (DEECD, 2013a). In addition, between 2008 and 2011, two hundred primary school teachers were selected and trained as Teaching and Learning Coaches, which was funded by the DEECD. This initiative focused on supporting teachers' professional learning in mathematics and science instruction. These Teaching and Learning Coaches provided "intensive assistance to identified schools to bring about the changes in classroom practice … to improve student outcomes in mathematics and science" (ACER, 2009, p. 53).

In late 2009, the DEECD introduced the first *Primary Mathematics Specialists* (PMS) teachers program designed to build the disciplinary and pedagogical knowledge of the specialists (DEECD, 2013a, 2014). The formal specialist role ran from 2010 – 2012 and involved 81 specialists (three specialists working in each of the 27 participating schools) who were appointed and provided with an intensive 10-day professional development program aimed to build teachers' capacity to improve mathematics learning outcomes for primary students. An evaluation of the *Primary Mathematics Specialists* program by Royal Melbourne Institute of Technology (RMIT University) found "substantial change in how mathematics was understood, organised and taught in most of the schools participating in the initiative" (DEECD, 2013a, p. 13). It was these findings and recommendations that "informed the development and implementation of the *Primary Mathematics and Science Specialists* initiative (2012-2015)" (DEECD, 2013a, p. 13).

The *Primary Mathematics and Science Specialists* (PMSS) program was introduced as part of a broader strategy aimed at improving mathematics and science education in Victorian schools. Subsequently, in 2012, the Victorian Government announced there would be 100 mathematics and science specialist teachers trained to work in Victorian government primary schools over the next two years, and another 100 in 2014 to 2015. Due to its success this government initiative has continued. Funding has been provided by the Victorian Government to train 200 more mathematics and science specialists over four years (2016-2019) (Department of Education and Training [DET], 2017a, 2017b), and at the time of writing another group began as part of cohort 6 (2021-2022).

Bastow Leading Numeracy was an additional element of the project available for teachers in Victorian schools as part of the implementation plan of the National Partnership Agreement on Improving Literacy and Numeracy. The focus of this course was on the professional development of leaders of mathematics with the aim of developing school leaders' knowledge and capacity to improve student performance in numeracy. More recently, this course has become known as Bastow Leading Mathematics and is offered in Victoria by the Bastow Institute of Leadership. The program included 7 days of professional development over a school year, where teams of three (principal, School

Mathematics Leader, and one teacher) were introduced to evidence-based approaches to develop leadership capabilities for supporting teachers to be more effective in teaching mathematics (DEECD, 2014). A series of courses have also been offered in a Victoria wide initiative by the Department of Education through the Bastow Institute incorporating mathematics leadership, currently called the *Numeracy Suite* (Bastow Institute for Educational Leadership, 2019; DET, 2017b).

Along with these professional development programs, there has been a focus on improving mathematics teaching and learning through the release of mathematics related documents on the Education Department website designed to support teachers, school leadership teams and parents. For example, the Birth to Level 10 Numeracy Guide (Department of Education and Training [DET], 2018), the Literacy and Numeracy Strategy Version 1 (DET, 2017b) and the Literacy and Numeracy Strategy Phase 2: Achieving Excellence and Equity in Literacy and Numeracy (DET, 2018).

1.5 School Mathematics Leader

The School Mathematics Leader role is sometimes defined in the literature using terms such as, *mathematics co-ordinator* (Millett, 1998; Millett & Johnson, 2000, 2007), *lead teacher* (Higgins & Bonne, 2011), *numeracy coordinator* (Corbin, McNamara & Williams, 2003; Cheeseman & Clarke, 2005, 2006) and *middle leader* (Jorgensen, 2016; Grootenboer, Edwards-Groves, & Rönnerman, 2015). For the purposes of this study the term *School Mathematics Leader* was used. Teachers often seek the knowledge and advice of School Mathematics Leaders when planning and teaching mathematics lessons. “Such leaders are knowledgeable, on-site teachers who support their colleagues’ efforts to interact about all facets of mathematics teaching” (Campbell & Malkus, 2013, p. 198). School Mathematics Leaders also have a significant role to play in improving mathematics teaching and learning in schools. According to Millet and Johnson (2007), School Mathematics Leaders or subject leaders as they were called in the United Kingdom, are “the most immediate source of professional development in mathematics for the primary teacher” (p. 19). The role is complex and demanding (Cheeseman & Clarke, 2005) and according to Millet and Johnson (2000) there are certain struggles and tensions that exist with School Mathematics Leaders often making “enormous demands on themselves in terms of curriculum and pedagogic skills” (p. 396).

1.6 The Problem

Previous research has reported that School Mathematics Leaders are "the most immediate source of professional development in mathematics for the primary teacher" (Millet & Johnson, 2007, p. 19). Teaching is a profession where practitioners "learn on the job." In fact, it is work that requires life-long learning, is complex and demanding, and in the primary school, teachers require both generalist and specialist curriculum knowledge, subject curriculum knowledge and subject content knowledge (Australian Institute for Teaching and School Leadership [AITSL], 2011; Ball, Thames & Phelps, 2008). In the case of mathematics education, the foundation of teachers' knowledge is learned in their undergraduate years, and their knowledge for teaching continues to grow through their experience and professional development over the course of their careers. Often the most powerful opportunities to learn about teaching and learning mathematics occur in schools with fellow teachers and students. A key person in this learning is often the School Mathematics Leader. The ways that mathematics leaders lead teachers to grow, develop and learn in schools are not well described in the research literature (Sexton & Downton, 2014b) and according to Cheeseman and Clarke (2006), "little detailed research is available regarding the execution of the role of numeracy coordinator in Australian primary schools" (p. 123).

1.7 Aims and Purpose of the Study

The aim of this study was to identify the ways in which School Mathematics Leaders supported teachers to develop effective practice in the teaching of mathematics which led to improved student learning outcomes. The purpose of this study was to gain a deeper understanding of how primary School Mathematics Leaders influenced teacher professional growth. This study also sought to identify the ways in which School Mathematics Leaders supported mathematics professional development of the teachers by encouraging, stimulating, and promoting teacher learning. It is hoped that the findings of this study will support the quality of teaching and learning of mathematics in primary schools by guiding and influencing future decisions and policy in relation to the education of all students and add to the literature in the field.

1.8 Research Questions

Several questions arose in relation to this study around the actions, skills, attitudes and beliefs School Mathematics Leaders demonstrate as they lead mathematics.

Consequently, the following research questions were designed to address the aims of the study and the data gathering process.

Major research question:

- How do School Mathematics Leaders support primary teachers' professional learning?

Subsidiary research questions:

- What challenges and successes do School Mathematics Leaders report when supporting primary teachers' professional learning?
- What challenges and successes do School Mathematics Leaders experience as they build professional learning communities?

1.9 My Personal Motivation

As a primary School Mathematics Leader, and a *Primary Mathematics Specialist* teacher since 2012, I have become increasingly aware of the importance of mathematics leadership and the ways leaders build active learning communities within their schools. Investigating the role that School Mathematics Leaders play in encouraging and supporting teachers to learn, is what drives and motivates me not only in my study, but also in my role as a teacher, and a School Mathematics Leader. My aim is to advocate for the role of the School Mathematics Leader and share with others how this role can be most effective at both the school and system level.

Looking back over the past eighteen years, two things had a huge impact on developing my enthusiasm for and understanding of mathematics teaching. First was the work of the Early Numeracy Research Project [ENRP], which was shared with schools, and second was a teaching colleague, who at the time was the Early Years Numeracy co-ordinator. Following a specialist role in my school teaching art I returned to the classroom and began working with this colleague in a team-teaching situation, teaching two classes of Year 1 and 2 students. It was my colleague's expertise and enthusiasm that influenced my love for teaching mathematics. This teaching partnership moulded my teaching philosophy, my confidence and my desire to learn more about ways in which I could make a difference to students in my care. As a result, I attended many mathematics professional development workshops and conferences. I then made the decision to complete a Masters in School

Leadership, specialising in Numeracy. In the following year, I was eager to continue to develop my interest in this area and was fortunate to be selected as one of two *Primary Mathematics Specialist* teachers at my school. This role prompted further interest in mathematics teaching and learning and a desire to support teachers in their work. During this time, two and a half days a week was allocated to the *Primary Mathematics Specialist* role of supporting teachers and students to learn.

A pivotal moment that led to this study, was when I was informed by the principal that my role as a *Primary Mathematics Specialist* teacher would finish when the funding ran out at the end of the two-year program. Although I would continue to be the School Mathematics Leader, I would be teaching full time in a classroom. Returning to the classroom as well as trying to be an effective School Mathematics Leader was challenging. The resulting frustration motivated my decision to seek ways to make a difference, which led to this research opportunity. My aim was to investigate the most effective ways School Mathematics Leaders could support teachers and students, and to identify the conditions for this to occur. The search continues to motivate me in the hope of making a difference to how teachers can learn to be better teachers of mathematics, which in turn will benefit the students in our schools.

1.10 Organisation of the Thesis

The thesis is organised into eight chapters. This chapter included a brief overview of the importance of this study, provided some context and described the purpose and aims of the research, my motivation and the research questions.

Chapter 2 contains a review of literature, including the theoretical frameworks underpinning the study. Literature on school leadership, teacher leadership and mathematics leadership in schools is discussed. This literature review also describes teachers' mathematical knowledge for teaching and research on how teachers learn. Potential opportunities for teacher learning are presented together with a review of the literature that describes professional learning communities, and how these impact on teachers' capacity to learn.

Chapter 3 is the methodology chapter and in it I describe the philosophical assumptions and motivation for conducting this research. The overall approach of the methodology and design of research is outlined. Data collection methods for the leadership survey (Phase 1) and four case studies (Phase 2) are described, as well as the five-phased cycle proposed by Yin (2016). The five phases provided structure during the analytical phase to answer the research questions. The chapter is concluded with an outline of steps taken to ensure ethical research practice occurred and issues of validity and reliability were addressed.

In Chapter 4 the results from the survey, Phase 1 of the study, are reported. In this chapter data and findings are presented. The data were analysed and discussed in connection to the relevant literature. In particular this section sets a background picture of the current nature of the role of the primary School Mathematics Leader as it is performed in Victorian Government schools. This information was also used as the basis for selection of four case study participants. Resulting themes are discussed and summarised in this chapter.

In Chapter 5 findings from Phase 2, the four case studies are presented. Following analysis of the evidence and guided by the research questions, particular aspects of the work of the School Mathematics Leaders are described and discussed in connection with the literature. Evidence is presented on ways in which each School Mathematics Leader believed they supported teachers' professional learning and development, as well as some of the challenges and successes they experienced.

In Chapter 6 a cross-case analysis of data is presented and discussed. Themes that emerged from analysis of the data, which included the survey, interviews, observations, videos and prompted written reflections are analysed and presented. Similarities and differences between the cases are presented.

In Chapter 7 the key findings are drawn together and discussed in relation to the research questions that framed the study. The discussion draws on the findings reported in Chapters 4, 5 and 6 and conceptualises the main findings of this research.

Chapter 8 concludes the thesis. A summary of findings is presented with a description of the ways in which effective School Mathematics Leaders support teachers professional learning. The limitations of the study are acknowledged, and practical implications for schools and system leaders are outlined, along with suggestions for further research.

Chapter 2: Literature Review

The purpose of this chapter is to present a review of literature relevant to the study. The theoretical frameworks underpinning the study are presented. This section is followed by a description of the research literature concerning the importance of mathematics and knowing how to teach it. A clarification is made between the terms, *mathematics* and *numeracy*. Literature on school leadership, effective school leadership, teacher leadership and mathematics leadership in schools is discussed, followed by literature related to teachers' mathematical knowledge for teaching and how teachers learn. Next the distinction is made between teacher professional learning and professional development. Finally, potential opportunities for teacher learning are presented, together with a review of the literature that describes professional learning communities, and how these impact on teachers' capacity to learn.

2.1 Theoretical Framework

The intent of this study was to identify ways in which School Mathematics Leaders supported teachers' professional learning. Therefore, teacher learning was the theoretical lens used to frame and guide the research design and data analysis to capture the complexities of the work of the School Mathematics Leaders. In addition, it was necessary to use a leadership framework (Fullan, 2001) for describing and analysing leadership, because the participants were leaders of mathematics in their schools. The practice of the School Mathematics Leaders was investigated to identify the ways each School Mathematics Leader led mathematics in their school and supported teachers to learn. Therefore, two fields of research literature informed the theoretical standpoint, and formed the framework for data analysis and interpretation of results. These fields of research – Leadership and how teachers learn were interrelated throughout this study.

The seminal works of eminent scholars provided a point of focus and guided the present research. In particular, the study drew on Lave and Wenger's (1991) work on social theory and Michael Fullan's (2001) Framework for Leadership (see Section 2.6, Figure 2.1). Lave and Wenger (1991) presented a social theory of learning and viewed learning as a characteristic of social practice. According to Wenger (2009), the primary focus of the theory of learning is on participants' learning within communities of practice. The ways in which these authors informed the research questions that investigated how School Mathematics Leaders built learning communities and led their teams of teachers will be detailed in Chapters 4, 5, 6, 7 and 8. In the next section the setting of mathematics education will be established to contextualise the research reported in this thesis.

2.2 The Importance of Mathematics

Mathematics is complex and underpins many aspects of our everyday lives (Council of Australian Governments [COAG], 2008). This study occurred at a time when continued development of the numeracy and mathematical competencies of students for their personal benefit was prioritised. Acknowledgement of the importance of mathematics education was evident in the move to a national curriculum with the development of the Australian Curriculum: Mathematics (Australian Curriculum and Assessment and Reporting Authority [ACARA], 2016, 2020). According to ACARA, "Learning mathematics creates opportunities for and enriches the lives of all Australians" (2016, para. 1). It was seen as important that teachers encourage students to develop an understanding of mathematical skills and knowledge, to be able to pose and solve problems and reason "in *number and algebra, measurement and geometry,* and *statistics and probability*" (ACARA, 2016, para. 1, emphasis in original). Encouraging students to be "confident, creative users and communicators of mathematics, able to investigate, represent and interpret situations in their personal and work lives and as active citizens" (ACARA, 2016, para. 1) was a priority.

Locally, the Victorian Government implemented the Victorian Curriculum Foundation-10 (Victorian Curriculum and Assessment Authority [VCAA], 2015) which incorporated the Australian Curriculum and reflected Victorian standards and priorities. The acknowledgement of the importance of mathematics was also evident with the introduction of the Literacy and Numeracy Strategy Version 1 (DET, 2017b) and the Literacy and Numeracy Strategy Phase 2: Achieving Excellence and Equity in Literacy and Numeracy (DET, 2018). This strategic approach from the Victorian Department of Education and Training described the importance of lifting numeracy achievement of school students to allow them to reach their full potential and become active informed citizens who could "contribute socially, culturally and economically" (DET, 2017b, p. 5) to our country's future.

2.3 Mathematics and Numeracy

Next the terms mathematics and numeracy are discussed and defined, as throughout the literature there is ambiguity with the terms being used almost interchangeably at times, but at other times being regarded as quite distinct (COAG, 2008).

> There is a diversity of opinions expressed on the nature of numeracy, ranging from those of some mathematicians who claim that numeracy does not exist, to some educators who claim it is synonymous with mathematics; and others who argue that the term ‘numeracy’ refers just to the use of mathematics in practical contexts. (Sullivan, 2011, p. 17)

According to the Australian Association of Mathematics Teachers [AAMT] “to be numerate is to use mathematics effectively to meet the general demands of life at home, in paid work and for participation in community and civic life” (1997, p. 15). *Numeracy* became the term for mathematics in the 1990s. It gained political favour as a verbal pairing of literacy and numeracy, and for more than a decade, as reported in the paper *Numeracy in Practice: Teaching, Learning and Using Mathematics* published by Australian Council for Educational Research [ACER] in 2009, was “a priority for all Commonwealth, state and territory governments” (p. 6). This priority was “reflected in the announcement of a National Plan for Literacy and Numeracy in March 1997 (Ministerial Council for Education, Employment, Training and Youth Affairs [MCEETYA], 1997), and the Numeracy Education Strategy Development Conference in May 1997” (ACER, 2009, p. 6). At the time, funding was provided for a number of numeracy research projects (ACER, 2009). It was pointed out that promotion of numeracy was a “key task for all … involved in schools … for those engaged in school leadership positions - principals and curriculum leaders - in developing school policies, in allocating resources and supporting teachers” (ACER, 2009, p. 2).

In 2008 the National Numeracy Review Report (COAG) made a number of recommendations to improve numeracy teaching and learning in Australian schools. The review found that while mathematics could be taught in the context of lessons, the development of numeracy required students to apply concepts they had learned beyond the mathematics classroom.

> Numeracy encompasses the knowledge, skills, behaviours and dispositions that students need to use mathematics in a wide range of situations. It involves students

> recognising and understanding the role of mathematics in the world and having the dispositions and capacities to use mathematical knowledge and skills purposefully. (Australian Curriculum, Assessment and Reporting Authority [ACARA], 2016, para.1)

The term *numeracy* is most commonly used in Australia to capture this practical perspective, while the term *mathematical literacy* is used in the same way in other countries and is measured in assessments such as PISA (Sullivan, 2011).

While mathematics, according to the Australian Curriculum,

> provides students with essential mathematical skills and knowledge in *number and algebra, measurement and geometry,* and *statistics and probability* (emphasis in original). It develops the numeracy capabilities that all students need in their personal, work and civic life, and provides the fundamentals on which mathematical specialties and professional applications of mathematics are built. (ACARA, 2016, para. 1)

According to the Melbourne Declaration on Educational Goals for Young Australians (MCEETYA, 2008), successful learners "have the essential skills in literacy and numeracy as a foundation for success in all learning areas" (p. 8). However, although students need high levels of numeracy to participate effectively in Australian society, school leavers and adults need mathematics for future careers, and in some cases a high level of mathematics proficiency is required (ACER, 2009). As mathematics is the subject taught in Victorian schools, it may "be helpful to think of numeracy as the key outcome of how mathematics is taught and learned" (ACER, 2009, p. 2).

It is important to consider the support that enables Victorian students to acquire the necessary knowledge and skills in mathematics to succeed, and how this can be achieved. Achieving successful outcomes in both numeracy and mathematics for all students is a key responsibility of teachers and school leadership. School leadership has an important role to play in implementing policies and resources that support effective teaching and learning of mathematics (ACER, 2009). This study aims to find the ways in which School Mathematics Leaders support teachers to develop effective practice in the teaching of mathematics.

2.4 The Importance of Knowing How to Teach Mathematics

Gaffney, Clarke and Faragher (2014) made the point that quality teaching leads to engaged, confident numeracy learners, and occurs as a consequence of teachers "who know their mathematics and know how to teach it" (p. 4). The Australian Professional Standards for Teachers (Australian Institute for Teaching and School Leadership [AITSL], 2011) were developed to "guide professional learning, practice and engagement" (p. 2). These standards also emphasised the importance of understanding mathematics and knowing how to teach it. They defined what teachers need to know, and do, and they make explicit key elements of high-quality teaching (AITSL, 2011, 2017). However, the challenge is in the implementation of the standards which can take considerable teacher professional learning.

Teachers are faced with many issues and challenges as they attempt to engage students in meaningful activities that develop students' understandings and mathematical dispositions. Sustained improvement in student learning of mathematics requires more than skilled teachers' who are confident in teaching mathematics. It requires a deliberate focus on the effective teaching of mathematics, along with high-level leadership capabilities (Gaffney & Faragher, 2010). Making a positive difference to student achievement requires school leaders who value teacher professional learning and who organise resources and structures to support teachers to work with their students (Gaffney, Clarke, et al., 2014).

2.5 Models of School Leadership

There is a large amount of literature that reports on school leadership (Timperley, 2011). Theories of leadership such as transformational, instructional and distributed leadership evolved and have been used increasingly in the discourse around school improvement (Dinham, 2016). Discussion of leadership theories is important in relation to mathematics curriculum leadership, as these theories provide insights into factors that impact the role of a School Mathematics Leader. Theories of transactional leadership, that focus on managerial activities, gave way with attention being paid to transformational leadership and distributed leadership (Vale et al., 2010) and more recently instructional leadership (Dinham, 2016). The characteristics of each of these leadership models are described in the next section.

Transformational leaders are "principals who engage with their teaching staff in ways that inspire them to new levels of energy, commitment, and moral purpose such that they work collaboratively to overcome challenges and reach ambitious goals" (Hattie, 2009, p. 83). A synthesis of evidence from studies on school leadership undertaken by Leithwood, Harris, and Hopkins (2008) found four core transformational leadership practices helpful in addressing performance in relation to teachers. The four practices incorporated within the construct of instructional leadership included, “building vision and setting directions; understanding and developing people; redesigning the organisation; and managing the teaching and learning programme” (Leithwood et al., 2008, p. 29). These practices, along with several more specific behaviours, according to Leithwood and colleagues (2008) provided a framework for practicing leaders that captured evidence of what successful leaders could do to support teachers. Although transformational approaches were advocated as productive (Leithwood & Jantzi, 1999), they were more focused on relationships between the leader and followers, than on work to improve teaching and learning (Robinson, Lloyd & Rowe, 2008), which led to the re-evaluation and regained prominence of instructional leadership (Dinham, 2016).

Instructional leadership, which had its origins in the late 1970s and early 1980s (Robinson et al., 2008) is similar in many ways to transformational leadership, yet it is more of a move away from the principal as an administrator, towards the principal as a learner and leader of learning (Vale et al., 2010). The focus of educational leaders moved towards the quality of teaching and their obligation to improve teaching and learning (Dinham, 2016). Instructional leadership is more about creating ideal conditions for effective teaching and learning for the promotion of student outcomes (Hattie, 2009). Both transformational and instructional leadership theories overlap to some extent, particularly in relation to developing people, their knowledge, skills and practices (Vale et al., 2010).

Distributed leadership grew in popularity and reflected changes based on the perspective that leadership tasks and responsibilities should be purposefully shared within the school (Harris, 2008; Harris & Spillane, 2008; Spillane, Halverson & Diamond, 2001). Studies of school improvement explored the extent to which distributive leadership built internal capacity (Harris, 2004; Spillane, 2005) and identified its importance as a contributor to school improvement (Dinham, 2016; Harris, 2014). The distributive leadership model, which is focused on teams rather than individuals, and was described by Harris (2004) as “a form of collective leadership in which teachers develop expertise by working together” (p. 14) is important in the case of leading mathematics in schools. It involves several leaders, for example in the context of Victoria, Australia: the principal, the curriculum specialist or School Mathematics Leader, and leading teachers working together in a coordinated way, engaging expertise within an organisation in an attempt to achieve high quality outcomes (Harris, 2004, 2014).

Distributed leadership is primarily concerned with leadership as a *practice,* rather than as a *role,* and should concentrate not only on what people do, but *how* and why they do it (Harris & Spillane, 2008; Spillane et al., 2001; Diamond & Spillane, 2016). Genuine distributive leadership needs to be carefully planned and coordinated to be most effective and is based on "high levels of trust, transparency and mutual respect" (Harris, 2014, p. 1). In a distributed model of leadership, the focus should be on the complex interactions and not just the actions of those leaders in formal and informal roles (Diamond & Spillane, 2016; Harris & Spillane, 2008; Harris, 2014). Harris and Spillane (2008) made the point that if we look at the relationship between 'leaders and followers' through an alternate lens, "that 'followers' may actually be a key element in defining leadership through their interactions with leaders" (p. 33). 'Followers' are critical elements in leadership practice (Spillane et al., 2001; Spillane, 2005) because without the followers there would be no leaders.

Distributed leadership was evident in an Australian project that ran from 2009-2011 designed to investigate the ability of students to achieve higher levels of numeracy in low socioeconomic communities, called the Leading Aligned Numeracy Project (LAND). A variety of schools from remote parts of the Northern Territory, the Kimberley, metropolitan Perth and Adelaide were involved. According to Gaffney, Bezzina and Branson (2014), despite each school following a different journey, there was a common thread which "involved combinations of leadership by principals and teachers, exercised in collaborative and complimentary ways" (p. 67) and reflected contemporary research in the connection made "between leadership and learning" (p. 68). The key question was how to maximise the potential of distributive leadership to ensure it led to school improvement (Harris & Spillane, 2008). By creating strong collaborative teams that included principals and teacher leaders with a focus on developing their own pedagogical content knowledge, these leaders-built learning communities, organised for teaching and learning and inspired a vision within their school settings (Gaffney & Faragher, 2010). The practice and activity of distributed leadership in the LAND project, took shape and emerged in and through the interacting components: the leaders, the followers, and the situation (Spillane et al., 2001; Spillane, 2005) which led to conditions that ensured improvement in mathematics teaching and learning.

While this research discussed a variety of different models of school leadership, the literature also suggests that leaders use a variety of different leadership styles (Goleman, 2000). The most effective leaders, according to Goleman (2000), switch between authoritative, democratic, affiliative, and coaching styles. Leadership is complex with the need to interact in different ways and in different situations. The most effective leaders are sensitive to the impact they have on others and seamlessly adjust and combine different interaction styles to get the best results (Goleman, 2000). A closer look at effective school leadership as revealed in the literature will be included in the next section.

2.6 Effective School Leadership

Levin and Fullan (2008) pointed out that “strong leadership does not just emerge; it must be developed and cultivated” (p. 295). Like Spillane (2005) and Harris (2008, 2014), Levin and Fullan (2008) acknowledged that schools need to build teacher leadership and suggested that leadership should not “be confined to those in official positions” (p. 295). Fullan (2002a) argued that an organisation cannot flourish by the actions of the top leader alone but suggested “there needs to be leaders at many levels” (p. 12). Fullan believed that “principal leadership that focused on the development of teachers’ knowledge and skills, professional community, program coherence, and technical resources” (2002a, p. 1) was at the heart of improving school capacity. However, despite the success of this model, leaders who have deeper and more lasting impact and provide effective school leadership have to be “much more sophisticated at conceptual thinking and transforming the organisation through people and teams” (Fullan, 2002a, p. 3). Fullan (2002a, 2002b, 2002c) saw school principals as more than instructional leaders, but as leaders “in a culture of change”, those who can transform the teaching profession and learning culture in schools. According to Fullan (1993) every person working in an organisation making improvements “must be change agents with moral purpose” (p. 39).

As part of his Framework for Leadership, (Figure 2.1) Fullan (2001) described personal characteristics necessary to lead complex change that supports sustained improvement in schools. The five core components of Fullan’s leadership framework include: “moral purpose, understanding change, relationship building, knowledge creation and sharing and coherence making” (2002c, p. 414).

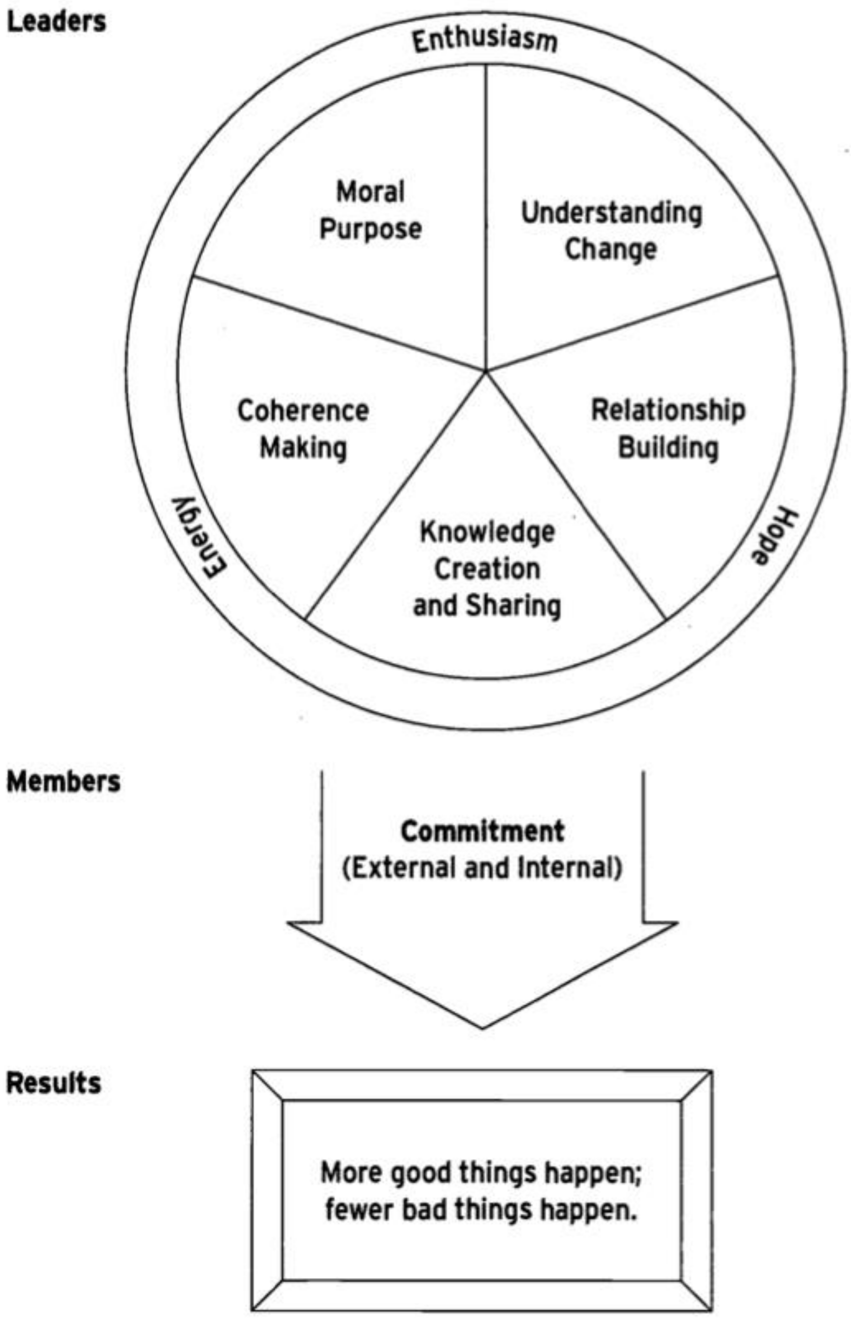

Figure 2.1. Framework for Leadership (Fullan, 2001, p. 4)

Fullan claimed leaders who incorporate all five of these components, along with the personal characteristics of energy, enthusiasm and hope into their daily behaviour, will be increasingly more effective and find the benefits and rewards enormous. This study was informed by Fullan's Framework for Leadership (Figure 2.1) with the focus on how these components work together to inform and identify effective mathematics leadership practice.

Following on from effective school leadership the next section discusses teacher leadership and more specifically mathematics leadership.

2.7 Teacher Leadership

Interest in distributive leadership prompted research reporting on teachers as leaders (Muijs & Harris, 2003). Over recent decades the practice and concept of teacher leadership gained momentum and became an increasingly important part of the language of educational improvement (York-Barr & Duke, 2004). Along with this change in the conception of leadership came the realisation that those in formal leadership positions such as the principal, could not carry all of the demands being placed upon them (Barth, 2001; Calderone, Kent & Green, 2018; Dinham, 2016; Harris & Townsend, 2007; Mangin, 2007; Timperley, 2005; Timperley, Ell, Le Fevre & Twyford, 2020; York-Barr & Duke, 2004). During the early 2000s there were also concerns in relation to improving the status of teaching (York-Barr & Duke, 2004). Initiatives were implemented to address the status of teaching that included more active participation by teachers in leadership (Fullan, 1993; Harris & Townsend, 2007; York-Barr & Duke, 2004). Fullan (1993) had been advocating for some time the active participation of teachers in initiating educational change. Similarly, Harris and Townsend (2007) and York-Barr and Duke (2004) also recommended an increase in teacher participation in leadership responsibilities.

Teacher leaders were considered experts in teaching and learning, there to support their colleagues, to improve the school culture and instructional practice that would lead to increased student achievement (Calderone et al., 2018; Mangin, 2007, 2009; Muijs & Harris, 2003; York-Barr & Duke, 2004). As effective classroom teachers, teacher leaders gained the respect and trust of their peers (York-Barr & Duke, 2004). The expertise of teacher leaders provided the foundation for improving teacher quality, leading to instructional improvement through such practices as modelling, sharing of effective instruction, mentoring and collaborating with teacher colleagues (York-Barr & Duke, 2004). According to Childs-Bowen, Moller and Scrivner (2000) “teachers are leaders when they function in professional communities to affect student learning; contribute to school improvement; inspire excellence in practice; and empower stakeholders to participate in educational improvement” (p. 28). Teacher leaders were recognised to have the potential to significantly affect the quality of teaching and learning in individual schools (Calderone et al., 2018; Dinham, 2016; Mangin 2009; York-Barr & Duke, 2004).

While Barth (2001) and Dinham (2016) pointed out that all teachers possess the ability to lead, according to York-Barr and Duke (2004) the need for more teachers to actively participate in leadership was evident. There was growing recognition of the potential of unrealised leadership in schools (Barth, 2001; Calderone et al., 2018; Dinham, 2016; Harris & Townsend, 2007) along with the realisation that subject leadership was "important in facilitating quality teaching and learning and school improvement" (Dinham, 2016, p. 185). The literature also suggested the importance of principal support to the success of the teacher leadership role (Barth, 2001; Mangin, 2007; York-Barr & Duke, 2004).

Teacher leadership brings with it many benefits (Mangin, 2007). The lives of teachers who pursue leadership opportunities can be "enriched and energised in many ways" (Barth, 2001, p. 445). Involvement in aspects of school improvement can increase the teacher leaders' engagement and motivation for their work (York-Barr & Duke, 2004). Teachers who lead can grow their understanding of instructional and organisational practice (York-Barr & Duke, 2004). Teacher leaders enjoy variety in their work, have the opportunity to gain some relief from the work of the classroom, and the chance to work with both teachers and students (Barth, 2001). According to Dinham (2016) "teacher leadership is important in growing organisational and individual capacity" (p. 181). The teachers who lead, influence decisions related to teaching and learning that shape their schools (Barth, 2001; York-Barr & Duke, 2004). Barth (2001) said that "teachers who assume responsibility for something they care desperately about … stand at the gate of profound learning" (p. 445). It is these leaders who provide opportunities for teacher professional growth, which is "where teacher leadership and professional development intersect" (Barth, 2001, p. 445).

Despite the benefits and opportunities, many teacher leaders choose not to lead because the responsibility adds to their already heavy workload, takes time, and accountability pressures are also discouraging (Barth, 2001). Teacher leaders sometimes experience insecurity due to their school's culture, including resentment and passive and active resistance from teacher colleagues, which can be obstacles to becoming a leader (Barth, 2001; York-Barr & Duke, 2004). Despite these obstacles, "one of the clearest effects of teacher leadership is growth and learning among the teacher leaders themselves" (York-Barr & Duke, 2004, p. 259). These leaders have the opportunity to influence the conditions of teaching and learning for adults and children in schools.

While the literature supports the idea that there is a need for teacher leaders (Barth, 2001; York-Barr & Duke, 2004), the challenge for education sectors is to decide the most effective ways to utilise teacher leaders. Teacher leadership is seen as the means by which teachers influence their colleagues, principals, and school community, to improve student learning (York-Barr & Duke, 2004). However, a study found that principal support was vital for effective teacher leadership (Mangin, 2007). The study which focused specifically on the nature and scope of work of the mathematics teacher leader, found links between the level of support provided by principals and the teacher leadership role, their knowledge of leadership and their interactions (Mangin, 2007).

Mathematics leadership will be discussed in the next section as the focus of this particular study.

2.8 Mathematics Leadership

2.8.1 Defining the term 'School Mathematics Leader'.

It is the leadership of mathematics that is the focus of this study, therefore it is important to define this role. Over time various terms have been used to describe the mathematics leadership role internationally and in Australia. In the United Kingdom the terms *subject coordinator, post holder* and *primary mathematics coordinator* have been used (Millett, 1998; Millett & Johnson, 2000, 2007). While Corbin, McNamara and Williams (2003) used the term *numeracy coordinator.* The term *lead teacher* was used in schools in New Zealand (Higgins & Bonne, 2011; Thomas & Ward, 2006), as well as the terms *mentor* and *coach* (Hunter, Hunter, Bills, & Thompson, 2016). While in the United States many schools have used the term *elementary mathematics leader* (Fennell, Kobett & Wray, 2013), *mathematics teacher leader*, and *mathematics specialist* or *coach* (Campbell & Malkus, 2011, 2013; Cobb & Jackson, 2011; Gibbons & Cobb, 2016, 2017; Jackson & Cobb, 2013).

Several projects initiated in Australia to support teachers in leading the development of improved mathematics education in schools have referred to leaders of mathematics as *teaching and learning coaches* (Anstey & Clarke, 2010), *numeracy leaders* or *numeracy coordinators* (Cheeseman & Clarke, 2005, 2006; Vale et al., 2010), and *middle leaders* (Grootenboer et al., 2015; Jorgensen, 2016; Roche, Russo, Kalogeropoulos & Vale, 2020). *School Mathematics Leaders* (Clarke et al., 2013; Sexton & Downton, 2014a, 2014b; Sexton, 2019), is a term also used in many Victorian government schools, and in some cases the term *Primary Mathematics Specialist* (Burrows, Parker & Brown, 2019; DEECD, 2013a, 2014; DET, 2017a) teacher is used.

Recently in New South Wales [NSW] the term *Instructional Leader* was also used. This term was used for school leaders who were responsible for extending teachers' mathematics knowledge and capabilities to improve student outcomes in the early years, as part of the "State government's State Literacy and Numeracy Plan (2017-2020)" (p. 10) implemented in *Early Action for Success* [EAfS] schools (Bobis, 2019; Erebus International, 2017).

2.8.2 Clarifying the term 'School Mathematics Leader'.

When reading the background literature for this study, terms such as coach, mathematics specialist, facilitator, mentor, numeracy leader, instructional leader and middle leader were used synonymously to "refer to a professional who supports classroom teachers with their mathematics teaching" (Polly, 2012, p. 81). The number of terms used interchangeably became problematic (Gallant & Gilham, 2014), therefore for consistency in the context of this study, the term School Mathematics Leader was coined and applied to teachers with the responsibility of leading improvement in mathematics in schools. This study focused on primary School Mathematics Leaders who supported teachers to improve their practice and potentially improve student outcomes. Ultimately the School Mathematics Leaders were charged with supporting teachers to learn to be better teachers of mathematics.

The use of different terms and contexts were particularly apparent in many studies in the United States, where mathematics specialists or coaches were placed in schools to provide on-site professional development in mathematics content and pedagogical knowledge and curriculum, to improve instruction and enhance student achievement (Campbell & Malkus, 2011, 2013). Similarities existed in the work of the mathematics specialists and coaches with that of the School Mathematics Leaders in this study. Coaching and mentoring were a large part of the work of the School Mathematics Leaders in schools in Victoria. Despite the terms being used interchangeably and within different contexts, the work of these leaders in mathematics was based on the same overarching philosophy of supporting teachers to learn, therefore it was important to acknowledge this work. Whether the School Mathematics Leaders worked across schools in a region, in a district, or were school based, ultimately, they were key to improving mathematics teaching and learning and influencing student outcomes. Therefore, based on similarities in their practice it was important that the work of these leaders of mathematics be included as part of the literature review.

2.8.3 Recognising the importance of School Mathematics Leadership.

Studies point to the importance of School Mathematics Leaders (Cheeseman & Clarke, 2005, 2006; Corbin et al., 2003; Faragher & Clarke, 2014; Grootenboer et al., 2015; Higgins & Bonne, 2011; Jorgensen, 2016; Sexton & Downton, 2014a, 2014b; Sexton & Lamb, 2017) who understand leadership, have the support of the principal and access to external expertise, and who are provided with the time and resources to work collaboratively with teachers (Anderson, Bobis & Way, 2008). Having a dedicated role allocated to leading mathematics is an essential feature for continued teacher professional learning and improved student achievement (Faragher & Clarke, 2014). The support that comes from a School Mathematics Leader contributes towards the development and practice of effective teaching of mathematics, along with the sharing of related ideas and insights essential for increasing effectiveness throughout the school (Faragher & Clarke, 2014). It is through actions and interactions with teachers, that School Mathematics Leaders "make a difference to the lives and learning of others, their professional colleagues as well as their students" (Gaffney, Bezzina, et al., 2014, p. 68).

Mathematics leadership at the individual school level varies according to the needs and context of each school, region and country. Government initiatives also have a key role to play, as they will often determine the current focus and any accountability measures for schools and regions (Ansty & Clarke, 2010). Government initiatives such as the *Education State: Literacy and Numeracy Strategy* (DET, 2017b) also influence the approach and investment schools take towards improving mathematics achievement across schools and systems. While investment by the Victorian Government in programs such as the *Primary Mathematics and Science Specialists* (Burrows et al., 2019; DET, 2017a, 2017b), *Leading Mathematics* (DET, 2017b, 2017c), and the *Numeracy Suite* (Bastow Institute for Educational Leadership, 2019; DET, 2017b) that offers a range of professional learning to develop leaders of mathematics, can influence the extent and effectiveness of the type of work in which future leaders of mathematics are engaged.

Mathematics leadership is a challenging, complex and demanding role that combines leadership and management in a number of ways (Bell & Ritchie, 1999; Cheeseman & Clarke, 2005, 2006). Leaders of mathematics are not always in formal positions such as school principals (Spillane, Healey & Parise, 2009); they are often classroom teachers with an additional responsibility of leading mathematics in their school (Higgins & Bonne, 2011). School Mathematics Leaders are commonly appointed by the principal in primary schools in Victoria, and although responsibilities might differ depending on the context of the school, the School Mathematics Leader plays a key role in improving mathematics teaching and learning. School Mathematics Leaders are considered "the most immediate source of professional development in mathematics for the primary teacher" (Millet & Johnson, 2007, p. 19) and an exemplary "source of in-school support" (p. 19).

School Mathematics Leaders or middle leaders in the words of Grootenboer, and colleagues (2015) are seen as critical educators in improving mathematics teaching and learning with the "capacity to bring about positive, practical and sustainable change" (p. 277). As instructional and curriculum leaders, their leadership practices impact on classroom practice, and also provide a link between the principal and classroom teachers. School Mathematics Leaders possibly "have the greatest impact on teacher learning and development" (Grootenboer et al., 2015, p. 278). Jorgensen (2016) also pointed out that School Mathematics Leaders were key to providing the necessary support for teachers to develop quality practices with in-class support and professional learning related to mathematical content and pedagogy. Both Jorgensen (2016) and Grootenboer et al., (2015) emphasised that School Mathematics Leaders played an important role in supporting teacher learning in classrooms. The findings of these two studies provided insights that highlight the importance of School Mathematics Leaders. An outline of the literature detailing some of the challenges and successes experienced by School Mathematics Leaders is presented in the following section.

2.8.4 Challenges experienced by School Mathematics Leaders.

School Mathematics Leaders face many challenges and many of the demands and tensions that exist in this role have not always been recognised (Millet, 1998). Results of a research project that focused on six schools following implementation of the National Numeracy Strategy in England, as part of the Leverhulme Numeracy Research Program, found that many mathematics leaders made "enormous demands on themselves in terms of curriculum and pedagogic skills" (Millett & Johnson, 2000, p. 396). The expectations of School Mathematics Leaders were high, and it was concerning that they did not always have the necessary resources and support to enact the role effectively (Millet, 1998). Many School Mathematics Leaders displayed various degrees of confidence (Millett & Johnson, 2000) and for some leaders the decision to demonstrate lessons in classrooms and lead by example was described as extremely stressful.

Examining the role of School Mathematics Leaders during the Early Numeracy Research Project (ENRP) and beyond the project in Australia, Cheeseman and Clarke (2005, 2006) found some of the difficulties when working with teachers included the need for encouragement and team building, and the need "for building acceptance and valuing of differences" (Cheeseman & Clarke, 2005, p. 231). Other difficulties included the amount of time School Mathematics Leaders spent on organisation and management, the extent of time release to facilitate the role, and variations in personal strengths exhibited by School Mathematics Leaders (Cheeseman & Clarke, 2005).

More recently, research by Sexton and Downton (2014a) also found that School Mathematics Leaders faced many challenges when enacting their role. School Mathematics Leaders involved in the Contemporary Teaching and Learning of Mathematics (CTLM) project believed they had experienced many successes but were concerned with the difficulty of sustaining improvement in mathematics education in their schools. Additionally, the School CTLM Leaders were concerned about maintaining the profile of mathematics in their schools and feared time release for planning would be discontinued once external project funding ceased. Limited budgets, managing resistant behaviour from teachers, and time constraints were also identified as challenges. Sexton and Downton (2014a) suggested that time constraints were a concern often expressed by School Mathematics Leaders, which could be due to the number of conflicting responsibilities associated with the leadership role.

Several challenges were also experienced by School Mathematics Leaders in a recent project in New South Wales, Australia, called Building Numeracy Leadership (BNL) for teachers in *Early Action for Success* [EAfS] schools (Bobis, 2019; Erebus International, 2017). School Mathematics Leaders in this project were pivotal in building teacher capacity to meet the complex needs of low performing students (Erebus International, 2017). Several challenges arose in relation to building teacher capacity that needed to be addressed, including the fact that many of the more experienced teachers had not undertaken any recent professional learning, because they believed they were effective teachers (Erebus International, 2017). There was also a large number of inexperienced teachers who had complex needs in terms of curriculum, pedagogy and classroom management. Another challenge experienced by the School Mathematics Leaders in this project was finding time within the regular school day to meet with teachers to provide specific professional learning. The professional learning included modelling, providing feedback following a lesson observation or demonstrating a strategy during team-teaching. Finally, a further challenge that arose which proved to be a key question to consider, and one faced by many similar projects, was how to sustain the impact of the project after funding had ceased (Erebus International, 2017).

2.8.4.1 Time allocated to School Mathematics Leaders.

Time has frequently been expressed as a challenge to the work of School Mathematics Leaders. Millett and Johnson (2000) argued that lack of time to visit classrooms to gain an overview of mathematics in schools and to support teachers was a major factor that influenced success of the role. Additionally, these two authors went on to say that “lack of time and support for the subject leader” (p. 406), or in this case the School Mathematics Leader, could have an effect on the leaders’ professional growth. Several researchers (Campbell, 1985, as cited in Millett, 1998; Nias et al., 1989, as cited in Millett, 1998) also noted that a lack of time School Mathematics Leaders could devote to their role, was a major factor influencing the way they enacted their role. These researchers also commented on the need for School Mathematics Leaders to use any spare moments in the day, including their own personal time to meet informally.

Millett (1998) also pointed out that many primary School Mathematics Leaders often have the added responsibility of classroom teaching, in addition to their curriculum responsibility, which can be a conflicting priority and increase demands of the role. Whereas in the United Kingdom, class responsibility was not only seen as “an onerous and time-consuming one” (Millett, 1998, p. 240), but the leader’s confidence in his or her role could also be affected by limited teaching experiences across all grade levels. Gaffney, Faragher and Clarke (2014) found a similar issue related to time with School Mathematics Leaders involved in the LAND project. Many School Mathematics Leaders were allocated time to enact the role, but in some cases the role was performed in conjunction with a normal teaching role, depending on funding and organisational arrangements at each school (Gaffney, Faragher, et al., 2014).

Similarly, variations of time allocated to the role, was an issue experienced by mathematics leaders involved in the ENRP (Cheeseman & Clarke, 2005). The recommendation given to the educational authorities in regard to the allocation of time to the role of the School Mathematics Leaders was as follows:

> It is recommended that Early Numeracy Coordinators be given a formal time release from class using the formula of five hours per week base, plus two hours per week for each staff member working in early years numeracy in the school. (Clarke et al., 2002, p. 27)

This recommendation acknowledged that to achieve success as a School Mathematics Leader it is necessary to have formal time allocated to the role.

2.8.5 Factors that led to success for School Mathematics Leaders.

The School Mathematics Leader plays a critical role in supporting teachers to develop highly effective practices in teaching mathematics in classrooms. Such practices can lead to many positive outcomes as described in the literature. During research of mathematics leaders in schools involved in the National Numeracy Strategy in the United Kingdom, Millett and Johnson (2000) suggested that increased challenges and demands had in some cases been positive. Millett and Johnson (2000) made the point that mathematics leaders who were well supported in their schools were able to grow professionally as they enacted their role. It should also be noted that, there was the appearance of greater consistency and coherence in the views of different members of the school community in relation to mathematics, resourcing had lifted the priority given to mathematics in schools, and external training and consultant support became available and was positively supported (Millett & Johnson, 2000).

Cheeseman and Clarke (2005) claimed that despite some challenges, the numeracy coordinators or School Mathematics Leaders experienced highlights related to aspects of the role. According to these authors, Leaders showed considerable professional growth and were able to provide substantial support and professional development to their team members. Many of the School Mathematics Leaders reflected on how they had changed in a positive light since the project and said that confidence in their own leadership ability had increased. Additionally, their ability to communicate, support others and their willingness to show initiative also improved (Cheeseman & Clarke, 2005).

In their work in the Contemporary Teaching and Learning of Mathematics (CTLM) project Sexton and Downtown (2014a) found improved mathematics planning practices to be one of the successes experienced by School Mathematics Leaders. Following involvement in the project both researchers reported a transformed culture in relation to mathematics, increased professional dialogue and greater use of mathematics assessment data and quality mathematics tasks.

Several studies in the United States (Cobb & Jackson, 2015; Gibbons & Cobb, 2016; 2017; Gibbons, Kazemi & Lewis, 2017; Jackson & Cobb, 2013) that examined mathematics leadership practice are also worth mentioning in terms of their success. Some mathematics leaders worked at a district level with many working in individual schools. Again, similar terms have been used for the mathematics leaders such as facilitator, teacher educator, mathematics specialist and mathematics coach. These mathematics leaders worked with teachers as the more accomplished colleague to improve instructional practice in the teaching of mathematics, therefore for the purposes of this study they are described as School Mathematics Leaders and have been included as part of the literature.

One particular study (Gibbons et al., 2017) in the United States examined the role a mathematics coach played in supporting the learning of a group of teachers in a primary school setting. Findings from the study revealed improvement in the quality of classroom instruction and strengthened teacher professional community. The Leader provided teachers with ongoing support through school-based mathematics coaching. The study involved job-embedded professional learning opportunities where teachers were supported by the Leader and engaged in shared experiences in primary classrooms to work on identified learning goals. Improved instructional practices and success was achieved as the Leader led weekly planning meetings, supported teachers one-on-one in classrooms during implementation of mathematics lessons and provided in-the-moment assistance and opportunities to debrief following lessons (Gibbons et al., 2017).

Findings from another study (Gibbons & Cobb, 2016) in the United States which highlighted success of mathematics leadership, reported on the work of an accomplished mathematics Leader in her school. The findings helped clarify what effective Leaders needed “to know and be able to do” (Gibbons & Cobb, 2016, p. 256) to support teachers to develop “ambitious instructional practices: co-teaching, modeling, observing and debriefing” (Gibbons & Cobb, 2016, p. 244). Teachers were provided with job-embedded support as they co-developed and co-enacted lessons in an attempt to improve the quality of instruction and student learning. As a result, knowledge and coaching practices that fostered teacher learning were identified and contributed to clarifying what School Mathematics Leaders needed to know and do to support teachers effectively, and to develop their practice.

Similarly, but in a different context, experienced mathematics teachers involved in the Developing Mathematical Inquiry Communities (DMIC) project in New Zealand, worked as mentors in classrooms to support teachers' professional learning, and found their actions and prompts caused reflective change in the transformation of pedagogical mathematical practices (Hunter et al., 2016). Although not specifically referred to as School Mathematics Leaders, the mentors or coaches, "illustrated high levels of expertise" (p. 61) in the teaching of mathematics and supported teachers to learn. These mentors "worked alongside [teachers] … as they taught a lesson" (p. 65), co-constructing mathematics together and provided teachers with the support, coaching and guidance they needed. Relationships established with teachers allowed the mentors to offer suggestions and to step in and out of lessons at critical moments. The in-class support, the actions and the prompts used, enabled teachers to reflect on their teaching and adopt new practices. According to Hunter and her colleagues (2016) "learning by leading [was] … at the core of this work" (p. 71) in which all participants were committed to improving best practice in mathematics pedagogy.

Finally, positive outcomes in relation to the work of School Mathematics Leaders were also outlined in a recent Australian report based on the Building Numeracy Leadership (BNL) for teachers in the *Early Action for Success* [EAfS] schools (Bobis, 2019; Erebus International, 2017) project. Bobis (2019) analysed and evaluated the effectiveness of the impact of the project on teacher participants' knowledge and teaching practices. School Mathematics Leaders provided professional learning and in-class support for teachers in targeted schools. Findings in the report indicated that there were positive changes to teachers' instructional practice, their mathematical knowledge and pedagogy, and to teachers' confidence to teach mathematics as a result of this project and the work of the School Mathematics Leaders.

School leadership, teacher leadership and mathematics leadership have been the focus of the previous sections. The literature concerning mathematical knowledge for teaching and how teachers learn this knowledge through various forms of teacher professional learning and development will be detailed next.

This section begins with an outline of the origins and nature of the overarching construct of *mathematical knowledge for teaching* (MKT) that combines *mathematical content knowledge* (MCK) and *pedagogical content knowledge* (PCK).

2.9 Mathematical Knowledge for Teaching

It has been argued that teachers need a solid understanding of mathematical content knowledge for teaching (Ball, 2000; Ball et al., 2008; Hilton & Hilton, 2019; Hoover, Mosvold, Ball & Lai, 2016; Loughran, Berry, & Mulhall, 2012; Petrou & Golding, 2011; Shulman, 1986, 1987; Thames & Ball, 2010). Teachers must know the content of the subject they teach to help students learn (Ball, 2000, Ball et al., 2008). While knowing the content is critical, this may not be sufficient (Ball, 2000; Ball et al., 2008; Hilton & Hilton, 2019; Petrou & Golding, 2011) as teaching mathematics requires more than just delivering content knowledge to students (Loughran et al., 2012). Teaching requires significant mathematical knowledge, skill and understanding linked with the ability to make decisions in the classroom based on professional judgements (Thames & Ball, 2010; Shulman, 1986, 1987). According to Loughran et al., (2012) this "rich conceptual understanding combined with expertise in developing, using and adapting teaching procedures, strategies and approaches" (p. 7) is the link between the knowledge of content and knowledge of pedagogy as introduced by Shulman (1986, 1987).

In his seminal work Shulman (1986, 1987) drew attention to the fact that teaching a subject requires more than just knowledge. Shulman (1986, 1987) and his colleagues suggested that teachers of mathematics need a special kind of knowledge that blends content knowledge and pedagogical knowledge, and introduced the term *pedagogical content knowledge,* or PCK. This *pedagogical content knowledge* was defined as "a second kind of content knowledge … which goes beyond knowledge of subject matter per se to the dimension of subject matter *for teaching*" (Shulman, 1986, p. 9, emphasis in original).

Shulman (1987) outlined the following seven types of teacher knowledge that underlie teacher understanding of what is needed to support student learning:

- Content knowledge
- General pedagogical knowledge, with special reference to those broad principles and strategies of classroom management and organisation that appear to transcend subject matter
- Curriculum knowledge, with particular grasp of the materials and programs that serve as "tools of the trade" for teachers

- Pedagogical content knowledge, that special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of professional understanding
- Knowledge of learners and their characteristics
- Knowledge of educational contexts, ranging from the workings of the group or classroom, the governance and financing of school districts, to the character of communities and cultures; and
- Knowledge of educational ends, purposes, and values, and their philosophical and historical grounds. (p. 8)

These categories highlighted the important role of pedagogical content knowledge as a distinct body of knowledge for teaching, as they represented the merging of content and pedagogy (Shulman, 1987). *Content knowledge, curriculum knowledge* and according to Ball et al., (2008) possibly the most influential, *pedagogical content knowledge* received more attention by Shulman and colleagues. Together these three categories which described teacher knowledge, composed "what Shulman referred to as, the missing paradigm in research on teaching" (Petrou & Goulding, 2011, p. 11).

Building on the work of Shulman (1986, 1987; Shulman & Shulman, 2004), Ball and her colleagues (2008) spent time studying actual mathematics teaching and developed a framework categorising the knowledge required for teaching effectively. These authors (Ball et al., 2008) hypothesised that teachers would be more likely to learn to teach mathematics if they were able to clearly identify the types of knowledge needed. Based on their analysis of the demands of mathematical teaching, Ball and colleagues (Ball et al., 2008; Hill, Ball, & Schilling, 2008; Thames & Ball, 2010) extended the ideas of Shulman and identified and developed the Domains of Mathematical Knowledge for Teaching framework presented in Figure 2.2.

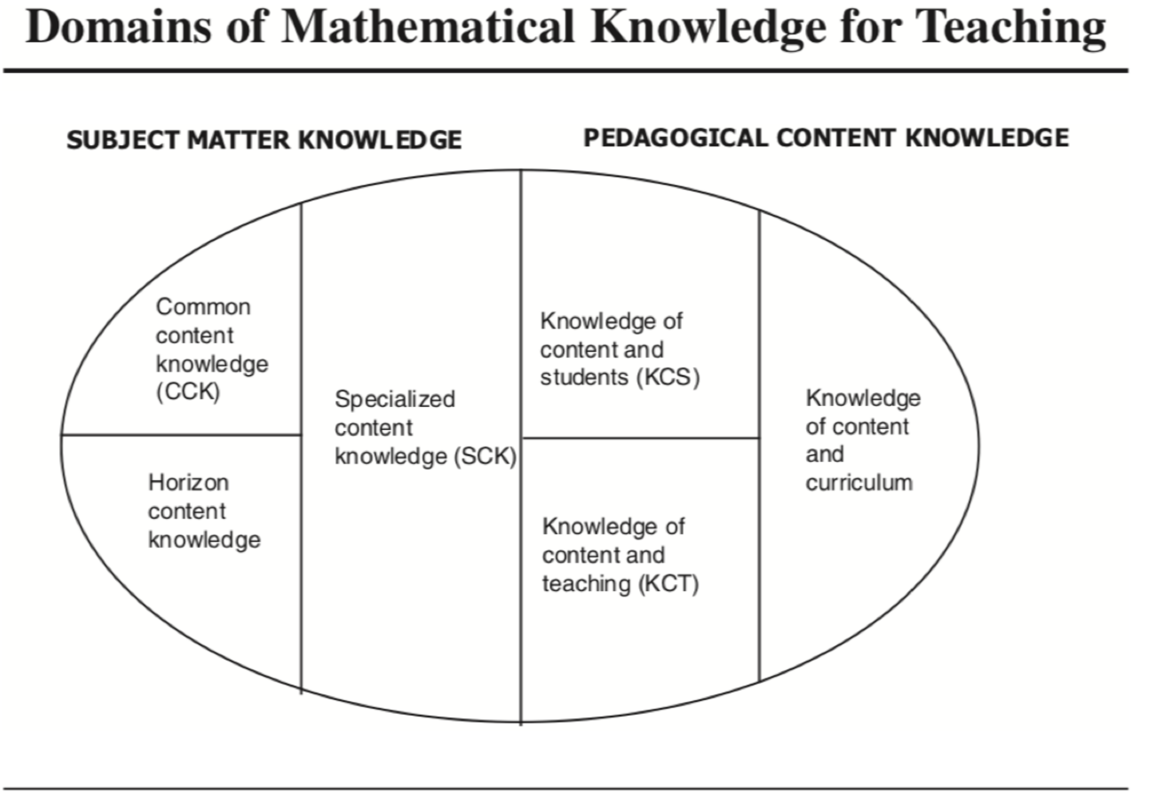

Figure 2.2. Domains of mathematical knowledge for teaching framework (Ball et al., 2008, p. 403)

Ball et al., (2008) created the framework that includes two larger domains: subject matter knowledge and pedagogical content knowledge (PCK). Three categories are grouped under each domain. Subject matter knowledge for teaching consists of *common content knowledge* (CCK), defined as the mathematical knowledge and skill used in settings other than teaching which is not unique to teaching. The second category suggested is *specialised content knowledge* (SCK), or the mathematical knowledge and skill unique to teaching, and the third category is *horizon content knowledge* (HCK), which is when a teacher demonstrates understanding of how mathematics topics are connected across the curriculum knowing how they are related and developed (Ball et al., 2008).

Pedagogical content knowledge consists of *knowledge of content and students* (KCS), defined as knowing the students and knowing the mathematics (Ball et al., 2008). Next is *knowledge of content and teaching* (KCT), which combines knowing about teaching and knowing about mathematics (Ball et al., 2008) and finally, *knowledge of content and curriculum* (KCC). This category is described as the knowledge that combines knowing about mathematics and knowing how mathematics is represented in curriculum documents and associated materials (Ball et al., 2008).

Much of the work of these researchers (Ball et al., 2008; Hill et al., 2008) extended that of Shulman by refining his conceptualisation of *pedagogical content knowledge* (PCK) and framing it using the overarching concept of *mathematical knowledge for teaching* (MKT). *Mathematical knowledge for teaching* (MKT) is possibly “the most influential reconceptualization of teachers’ PCK within mathematics education” (Depaepe, Verschaffel & Kelchtermans, 2013, p. 13). MKT integrates both *mathematical content knowledge* (MCK) and *pedagogical content knowledge* (PCK). Nevertheless, the concept of PCK continues to remain very influential in mathematics research on teaching and learning and in teacher education (Depaepe et al., 2013).

The theoretical frameworks conceptualising teacher knowledge were important in this study, as they underpinned the analysis of aspects of the interactions with teachers and the School Mathematics Leaders involved in the case studies.

2.9.1 Concerns regarding teachers’ mathematical knowledge for teaching.

Developing teachers’ specific mathematics content knowledge for teaching is a topic that has received attention for many years in the educational community (Darling-Hammond & Ball, 1998; Hill & Ball, 2004; Livy, Vale & Herbert, 2016; Loucks-Horsley, Stiles, Mundry, Love & Hewson, 2010; Ma, 1999; Thames & Ball, 2010). While it is generally accepted that teaching mathematics requires *mathematical content knowledge* (MCK), effective teaching encompasses more than content knowledge, it “involves significant, specialised mathematical knowledge and skill” (Thames & Ball, 2010, p. 226). Effective teaching requires teachers who have a deep understanding of the subject they teach, its structure, as well as an understanding of the types of activities that help students to learn (Bransford, Brown & Cocking, 2000). There is evidence that many teachers lack deep conceptual understanding of mathematics (Ball, Hill, & Bass, 2005; Ball, Lubienski & Mewborn, 2001; Ma, 1999; Stacey, 2010) and learnt to teach using a model which focused more on memorising facts rather than emphasising understanding of the content (Darling-Hammond & McLaughlin, 1995; Darling-Hammond, 1997; Garet, Porter, Desimore, Birman & Yoon, 2001). Additionally, studies support the idea that many teachers lack confidence in their ability to teach mathematics (Beswick, Watson, & Brown, 2006; Dinham, 2014; Fraser, Beswick & Crowley, 2019). In the United Kingdom, Millett (1998) found that many teachers who had to teach mathematics did not know enough about the subject, lacked confidence mathematically, and were not familiar with current ideas of teaching. While many teachers in the United States were also found to “lack the deep, nuanced, and specialised mathematical knowledge needed for responsible teaching" (Selling, Garcia & Ball, 2016, p. 36).

Australian studies also highlighted concerns about the level of primary teachers' mathematics knowledge for teaching (Gaffney & Faragher, 2010; Fraser et al., 2019; Hollingsworth, Lokan & McCrae, 2003; Lamb, 2010; Stacey, 2010; Stacey, Vincent, Stephens & Holton, 2015; Sullivan, 2011). Concerns were expressed about the level of content knowledge and conceptual understanding of mathematics held by primary school teachers' in Australian schools in the National Numeracy Review Report (Council of Australian Government [COAG], 2008). According to the report (COAG, 2008) knowledgeable teachers are key to improving teaching, which is dependent "on the ongoing professional development of teachers" (p. 70). A recommendation was made in the report (COAG, 2008) "that pedagogical content knowledge (that is, knowledge about teaching specific mathematical content) be a prime focus of both pre-service and in-service programmes for teachers of mathematics across all the years of schooling" (p. 73). Authors of this report (COAG, 2008) argued that there was a link between the quality of mathematics teaching and the provision of ongoing opportunities for teachers to learn. A further recommendation was that various exemplary "research-based professional development programs" (p. 73) such as *Count Me in Too* (CMIT), and the *Early Numeracy Research Project* (ENRP), aimed at early years' primary teachers, be extended and similar programs be made available to develop teachers' knowledge of mathematics teaching and learning (COAG, 2008).

Concerns about mathematical knowledge for teaching were also highlighted by Stacey and colleagues (2015) in the Desktop Review of Mathematics School Education Pedagogical Approaches and Learning Resources report. These authors (Stacey et al., 2015) explained that although there were many positive features in Australian classrooms, there was evidence of a "shallow teaching syndrome" with a reliance on worksheets and textbook teaching. It was also suggested in this report that many Australian teachers, primary and secondary, broke down potentially challenging problems into smaller steps so students had little opportunity for mathematising and communication, and missed the depth of the Australian curriculum. Stacey et al., (2015) believed mathematics pedagogical content knowledge (MPCK) considered to be key to successful teaching, was "inadequately developed in many teachers" (p. 9). These authors believed strengthening mathematical pedagogical content knowledge (MPCK) must be a priority, and as part of their report recommended “supporting expertise in mathematics teaching” (p. 34) by consolidating, refreshing, and creating resources to teach mathematical concepts based on best research evidence.

The research evidence suggested it was timely to investigate ways in which School Mathematics Leaders support teachers to develop their mathematical knowledge for teaching.

2.9.2 Developing teachers’ mathematical knowledge for teaching.

While teachers are said to be the greatest influence on student achievement (AITSL, 2017; Bransford et al., 2000; Dinham, 2007, 2016; Hattie, 2009; Lingard, Hayes, Mills & Christie, 2003; Lingard & Mills, 2003) there is a growing emphasis on the need to provide extensive learning opportunities and coordinated approaches for teachers to learn in order to enhance student learning (Bransford et al., 2000; Loucks-Horsley et al., 2010; Reaburn, Kilpatrick, Fraser, Beswick & Muir, 2016). Developing teachers’ mathematical knowledge for teaching typically involves teachers participating in professional development workshops, presentations, and courses that have the potential to lead to improved instructional practices (Bransford et al., 2000; Loucks-Horsley & Matsumoto, 1999; Putman & Borko, 2000).

2.10 How Teachers Learn

Many theories exist on how people learn. Learning theories can be described as “sets of principles that explain how learning occurs” (Siemon et al., 2011, p. 27) which cause “change in a person’s knowledge or behaviour” (Woolfolk & Margetts, 2010, p. 258). The focus of learning theories for the past century has been on changes to behaviour and thinking, but more recently evidence from neuroscience has also led to interest in the relationship between learning and brain function and development (Bransford et al., 2000, Siemon et al., 2011). Learning theories that have influenced teacher learning and are most relevant to this study, can be broadly categorised according to their focus on changing behaviour (practice), changing thinking (knowledge, beliefs, dispositions) and social participation.

Researchers have investigated ways in which teachers learn (Borko, Jacobs, Eiteljorg & Pittman, 2008; Clarke & Hollingsworth, 2002; Goldsmith, Doerr & Lewis, 2014; Opfer & Pedder, 2011). How practicing teachers continue to learn and develop the knowledge that enables them to teach well is complex. According to Cochran-Smith and

Lytle (1999), “teacher learning has become one of the most important concerns of the educational establishment” (p. 249). However, according to Bransford et al., (2000) there is not a lot of data in relation to teacher learning. Putnam and Borko (2000) made a similar point and suggested that little attention has been paid to teacher learning, but more specifically how teachers learn to teach. Additionally, Cobb and Jackson (2015) said “the number of studies that have investigated teachers’ learning is relatively small” (p. 1036). In contrast, more recently, literature has emerged that suggests that “since 2000 … there have been significant developments in research on learning” (National Academies Press, 2018, p. 16). The research that does exist on teacher learning has provided important information in relation to the need for teachers to continue to develop their knowledge and skills in teaching. Understanding how teachers learn, and the processes that occur when adults are learning, creates important implications for education (Bransford et al., 2000) and for this study.

While it could be assumed that “teachers who know more teach better” (Cochran-Smith & Lytle, 1999, p. 249), knowing exactly what it is that teachers need to know and how they will learn this knowledge is not clear (Loucks-Horsley & Matsumoto, 1999). According to Hollingsworth and Clarke (2017), a focus by researchers and educators at all levels is to try and understand the best ways for teachers to “learn to develop and refine their practice” (p. 458). A number of researchers have emphasised learning as an active process, and that “active learning requires opportunities to link previous knowledge with new understandings” (Cochran-Smith & Lytle, 1999, p. 258) through a process of change (Bransford et al., 2000; Clarke & Hollingsworth, 2002). Furthermore, learners bring prior knowledge and experience to learning situations, and create new concepts by constructing links to their existing knowledge (National Academies Press, 2018), rather than being told information by others (Cochran-Smith & Lytle, 1999). Research also suggests that learning “takes place over time rather than in isolated moments” (Cochran-Smith & Lytle, 1999, p. 258) and needs to be situated in meaningful and relevant contexts (Bransford et al., 2000, National Academies Press, 2018).

According to Lave (2009), “traditionally learning researchers have studied learning as if it were a process contained in the mind of the learner and have ignored the lived-in world” (p. 202). Situated learning theorists (Lave & Wenger, 1991) believe “learning is an integral and inseparable aspect of social practice” (p. 31) and that learning occurs by being active participants in a community of practice (Lave, 2009; Lave & Wenger, 1991, Wenger, 2009). Lave and Wenger (1991) described this way of learning as *legitimate peripheral participation,* where people learn, beginning as newcomers and progressing to full participants as they participate in a community of practice. Teacher learning takes place in meaningful contexts and is distributed across the individual, other people and artefacts, (Borko et al., 2008; Putnam & Borko, 2000) and is enhanced by developing communities of practice, where teachers participate in shared experiences and discourse around student data and learning (Bransford et al., 2000; Lave & Wenger, 1991).

In order to develop a better understanding of how teachers learn, several more recent studies (Chan et al., 2018; Chan, Roche, Clarke & Clarke, 2019) were undertaken situated in classroom practice. The researchers in these studies aimed to understand how teachers learnt the actual act of teaching in the classroom during their daily practice (Chan et al., 2018). Chan et al., (2019) found that "two different learning mechanisms" (p. 168) contributed to teacher learning. One of the mechanisms was "consolidation in terms of reinforcement of existing knowledge and beliefs, and the other [was] realisation of new knowledge and beliefs" (Chan et al., 2019, p. 169). These researchers argued that consolidation and realisation strengthened teacher knowledge and practice and therefore contributed to understanding how teachers learn in the classroom.

2.11 Teacher Professional Learning and Development

Throughout the literature the terms *professional learning* and *professional development* in relation to teacher learning are often used interchangeably (Anderson et al., 2008; Fullan & Hargreaves, 2016) with a lot of mutual interaction and overlap between the two terms (Fullan & Hargreaves, 2016). Professional learning, according to Fullan and Hargreaves (2016), "focuses on learning something new that is potentially of value" (p. 3), while professional development "refers to growth in terms of who you are and what you can do" (p. 3). Many American researchers (Borko, 2004; Cobb & Jackson, 2011; Darling-Hammond & Ball, 1998; Gibbons & Cobb, 2017; Guskey, 2002; Loucks-Horsley & Matsumoto, 1999; Loucks-Horsley et al., 2010) consistently use the term professional development. Whereas in Australia, although the term professional development is frequently used, more recently the term professional learning has become popular (Bobis, Kaur, Cartwright & Darragh, 2020) as schools place a greater emphasis on teachers working collaboratively in professional learning teams and communities of practice.

The distinction was highlighted by Anderson and colleagues (2008), who suggested that professional development refers to “planned, focused activities and formal programs that teachers undertake to extend their professional learning” (p. 313). While professional learning is seen as growth in teacher practice and expertise, which “may be achieved through participation in professional development experiences but may also be achieved through experience in the classroom, professional reading and postgraduate study and the like” (Anderson et al., 2008). A distinction was also made by Faragher, Southwell, and Gaffney (2014). They pointed out that,

> professional development usually refers to formal programs that take place away from one’s normal work situation, whereas professional learning is used to describe a process of continuing professional growth that occurs through regular, day-to-day work practices as well as in more formalised educational and training settings. (p.133)

These distinctions of the terms *professional learning* and *professional development* are used throughout this study. However, as several researchers (Anderson et al., 2008; Fullan & Hargreaves, 2016) have alluded to, the terms are often used interchangeably, depending on the source.

The importance of professional learning and development is recognized by the Australian Association of Mathematics Teachers (AAMT) (2006) in the Standards for Excellence in Teaching Mathematics in Australian Schools. Domain 2 described certain professional attributes and identified the importance of professional development in the following statement. Statement 2.1 Personal Professional Development states:

> Excellent teachers of mathematics are committed to the continual improvement of their teaching practice and take opportunities for personal professional development. They undertake sustained, purposeful professional growth in their own knowledge, understanding and skills in mathematics, and in the teaching and learning of mathematics. The professional development they undertake enables them to develop informed views about relevant current trends (including teaching and learning resources, technologies, and changes to the curriculum with which they work) and to further their teaching expertise. They are involved in professional development processes that include collegial interaction, professional reading and active exploration of new teaching ideas, practices and resources in the classroom.

They reflect on practice and the new knowledge they gain and learn from their experiences. (AAMT, 2006, p. 3)

The emphasis on teacher professional learning is also recognised at a national level in Australia in the Australian Professional Standards for Teachers (AITSL, 2011, 2017). The importance of ongoing learning is emphasised, as is the importance of modelling learning behaviour and expectations of teachers to engage with professional learning. The following standards, relevant focus areas, and descriptors are:

Standard 6: Engage in professional learning.

6.1 Identify and plan professional learning needs

6.2 Engage in professional learning and improve practice

6.3 Engage with colleagues and improve practice; and

6.4 Apply professional learning and improve student learning. (AITSL, 2011, 2017)

These educational bureaucracies recognise the need for teachers to engage in regular professional learning and development to improve their knowledge and skills. In Victoria, all teachers are required by the Victorian Institute of Teaching (VIT) to engage in at least 20 hours of accredited professional learning each year to maintain their registration as a teacher.

2.11.1 The complexity of teacher professional learning and development.

Professional learning and professional development are "central to change and improvement" (Timperley et al., 2020, p. ix) and are described as "deliberate ways to improve the quality of teaching" (Fullan & Hargreaves, 2016, p. 1). Engaging in professional development creates teachers who are better prepared to teach and support students to learn (Loucks-Horsely & Matsumoto, 1999). Despite recognition of the importance of professional development for ongoing learning, some authors (Borko, 2004; Guskey, 2002; Loucks-Horsley et al., 2010; Opfer & Pedder, 2011; Putnam & Borko, 2000) believed available opportunities in the past were inadequate, fragmented, superficial and did not always consider how teachers learn. In fact, they failed "to meet the needs of diverse learners in complex settings" (Timperley et al., 2020, p. 2). Much of what constituted the typical professional development workshop tended to be directly opposed to what research said about effective learning (Bransford et al., 2000). Evidence suggested that participation in the so-called “one-off” professional development workshop did not necessarily improve teacher practice (Clarke, 1994; Cheeseman & Clarke, 2006; Cobb & Jackson, 2015; Fullan & Quinn, 2016; Loucks-Horsley & Matsumoto, 1999; Raeburn et al., 2016; Timperley, 2011; Timperley et al., 2020) and it was also difficult to ascertain links between the professional development and improved student achievement (Anderson et al., 2008; InPraxis Group, 2006; Timperley, 2008; Timperley, 2011; Timperley et al., 2020). While many teacher educators also struggled with knowing “how to create learning experiences powerful enough to transform teachers’ classroom practice” (Putnam & Borko, 2000, p. 5). Professional development opportunities needed to enhance teacher knowledge, develop instructional practices and lead to student learning (Borko, 2004).

2.11.2 Effective teacher professional learning and development.

Research on effective teacher professional learning and development has increased in recent years (Anderson et al., 2008; Beswick, Anderson & Hurst, 2016; Beswick, Fraser & Crowley, 2017; Fullan & Hargreaves, 2016; Gibbons & Cobb, 2017; InPraxis Group, 2006; Jackson & Cobb, 2013; Koellner, Jacobs & Borko, 2011; Loucks-Horsley et al., 2010; Timperley, 2008, 2010; Timperley et al., 2020). However, there is still much to learn about what makes professional learning effective (Anderson et al., 2008; Beswick et al., 2016; Beswick et al., 2017), whether and when teachers develop mathematical knowledge, and what features contribute to this knowledge as a result of the professional development (Hill & Ball, 2004; Hill et al., 2008). Furthermore, Beswick et al., (2017) argued that “effectiveness cannot be claimed in the absence of rigorous evaluative evidence” (p. 169), believing that claims of effectiveness of professional learning are based on implied goals and teacher self-reports of improved confidence or practice and increased knowledge, rather than improved student outcomes.

A document released by the Department of Education and Training (2005) titled *Professional Learning in Effective Schools* recognised the connection between effective teaching and student improvement. According to this document, “engaging teachers in high quality professional learning is the most successful way to improve teacher effectiveness” (p. 2). The document outlined a vision for professional learning which included seven principles designed to underpin high quality effective professional learning in Victorian government schools.

The seven principles are:

1. Professional learning is focused on student outcomes (not just individual teacher needs)

2. Professional learning is focused on and embedded in teacher practice (not disconnected from the school)

3. Professional learning is informed by the best available research on effective learning and teaching (not just limited to what they currently know)

4. Professional learning is collaborative, involving reflection and feedback (not just individual inquiry)

5. Professional learning is evidence based and data driven (not anecdotal) to guide improvement and to measure impact)

6. Professional learning is ongoing, supported and fully integrated into the culture and operations of the system – schools, networks, regions and the centre (not episodic and fragmented)

7. Professional learning is an individual and collective responsibility at all levels of the system (not just the school level) and it is not optional. (DET, 2005)

These seven principles emphasised effective professional learning as collaborative, informed by research, focused on student outcomes and embedded in teachers' daily practice.

Loucks-Horsley et al., (2010) claimed that decisions related to the design of effective professional development should be grounded in research knowledge and based on the "particular needs, contexts and circumstances" (p. 3) of participating teachers. Effective professional development needs to be relevant, connect what teachers are learning to what they know, and provide them with new skills, but also "transform their thinking and deeply held beliefs about teaching and learning" (Loucks-Horsley et al., 2010, p. 16). Similarly, Darling-Hammond and McLaughlin (1995) believed effective professional development must provide opportunities for teachers to reflect on their practice so they can "adapt new knowledge and beliefs to their own teaching contexts" (p. 598). When designing and implementing professional development, what people know and believe are important considerations, as a teachers' beliefs inform how they "engage in and learn from professional development" (Loucks-Horsley et al., 2010, p. 2). However, it takes time for new understandings to be translated into beliefs and changes in practice (Loucks-Horsley et al., 2010; Timperley, 2008).

Research shows that "the most successful teacher professional development activities are those that are extended over time and encourage the development of teachers' learning communities" (Bransford et al., 2000, p. 204). Professional development activities that are sustained over time allow teachers "to develop, absorb, discuss and practice new knowledge" (Opfer & Pedder, 2011). These activities range from large-scale projects to smaller-scale projects. The impact on the professional learning of teachers arising from successful large-scale projects such as the *Count Me in Too* project in New South Wales (CMIT) and the *Early Numeracy Research Project* (ENRP) in Victoria was significant (Anderson et al., 2008). However, smaller scale "quality sustained professional development opportunities" (Anderson et al., 2008, p. 319) within a school context that explore teacher learning within classrooms, were also found to support teacher professional learning in many ways.

More recently in a review of Australasian research on teachers' professional learning and development in mathematics education, Bobis et al., (2020) claimed that the characteristics and design of effective professional learning have remained "fairly consistent over the past few decades" (p. 119) and are well recognised in the literature. A summary of these characteristics included "opportunities for active learning by teachers, extended timeframes, a shared purpose, informed by research, collaborative learning and research with other teachers" (Bobis et al., 2020, p. 119). Watson, Beswick, and Brown (2012) proposed a similar series of broad characteristics of effective professional learning for teachers, which also included among other things: connections to practice; a shared purpose underpinned by evidence of best practice; sustained over time; with a balance of "individual learning needs within the development of a community of practice" (p. 36). Although these characteristics appear to be similar, others (Beswick et al., 2016) have since suggested that "a more nuanced approach to conceptualising PL [professional learning] quality" (p. 348) may be necessary in determining its effectiveness, that takes into account the aims and context of particular initiatives, including the formal and informal learning experiences in which teachers engage (Beswick et al., 2017).

The connection between mathematics leadership and the implementation of effective professional learning and development will be described in the following section.

2.11.3 Professional learning and development and the School Mathematics Leader.

Clearly there is a need for professional development to enable teachers to be more effective (Muijs et al., 2014). In many Victorian schools School Mathematics Leaders are regularly expected to plan, co-ordinate and often implement professional development to support teacher learning (Cheeseman & Clarke, 2006; Sexton & Downton, 2014a; Sexton, 2019; Vale et al., 2010). Although School Mathematics Leaders play a critical role in co-ordinating and delivering professional development, some leaders do not necessarily have the resources or the support to carry this out effectively, and often feel they lack the experience, knowledge and skills to do so (Cheeseman & Clarke, 2006; Koellner et al., 2011; Millet, 1998). A recommendation made by Cheeseman and Clarke (2006) suggested that professional development be provided to prepare and sustain the work of School Mathematics Leaders to develop their understanding of leadership and to ensure high quality professional learning was available to teachers. Sullivan (2011) also suggested that particular programs be offered to current and prospective School Mathematics Leaders to ensure they receive the ongoing support necessary to maximise the benefit to students and teachers. A further recommendation made by Cheeseman and Clarke (2006) was the possibility of linking the School Mathematics Leader to an outside mathematics educator and establishing collegial networks as a means of support. These recommendations have important implications for the School Mathematics Leaders, teachers and students.

In summary, this section of the review defined and examined professional learning and professional development and some of the complexities. A number of points were made about the effectiveness of teacher professional learning and development as they appear in the literature, followed by how it relates to the School Mathematics Leader. As the knowledge base on professional learning and development has continued to grow, some reported opportunities for teachers to learn will be included in the following section. The focus will be on more specific in-school and classroom-based professional learning opportunities supported by the School Mathematics Leader.

2.12 Opportunities for Teachers to Learn

Research has led to new knowledge and beliefs which have transformed how educators think about teaching and learning and professional development (Anderson et al., 2008; Fullan & Hargreaves, 2016; Higgins & Parsons, 2011; Koellner et al., 2011; Loucks-Horsley et al., 2010; Muijs et al., 2014; Timperley et al., 2020). Loucks-Horsley et al., (2010) suggest the more traditional forms of professional development were narrowly focused and often ineffective, and now more attention has been paid "to providing professional development that is embedded into the regular structure of schools through arrangements such as study groups, professional learning communities and grade-level teams" (p. 19). Learning communities reduce isolation, develop teacher knowledge and encourage coherence (Loucks-Horsley et al., 2010).

2.12.1 School based professional learning and development.

A significant influence on improved student learning is the quality of teaching they experience (Hattie, 2009), which has resulted in a more concentrated effort to promote the professional development of teachers within the context of the school (Opfer & Pedder, 2011). In their work, Fullan and Hargreaves (2016) argued the importance of "getting beneath and beyond the surface of professional development by appreciating and demanding more" (p. 21). These authors believed the essence of success in schools was "to establish a culture of collaborative professionalism in which teachers develop and grow day by day through feedback and joint work" (p. 21), engaging in pedagogy and developing mutual trust. According to Cobb and Jackson (2015), teacher collaboration provided significant learning opportunities, but they also made the point that the extent to which this collaboration supported teacher learning depended on the quality of leadership and the inclusion of already accomplished teachers. School Mathematics Leaders are likely to be accomplished teachers who are able to share their "wisdom of practice" (Clarke, 1994; Bransford et al., 2000; Shulman, 1986, 1987) and expertise with teachers, as they work together in professional learning communities, reviewing student work and sharing pedagogy and curriculum.

Professional learning teams provide learning opportunities in the context of teachers' daily work. An important recommendation came from the National Numeracy Review Report (COAG, 2008), a review of evidence-based research on good practice in numeracy and the learning of mathematics, that led to the establishment of Professional Learning Teams in schools. Based on evidence from the ENRP, the review stated there was a "need for supportive in school structures to support teacher learning" (COAG, 2008, p. 74) and recommended that,

> schools form professional learning teams that focus on mathematics education, to provide a forum for collegial discourse, professional development, and team monitoring of student performance in mathematics. (Clarke et al., 2002, p. 28, as cited in COAG, 2008, p.74)

While we know teachers learn through various types of professional development, including working in professional learning teams, recognition of approaches that are situated within teachers' classrooms are also important.

2.12.2 Professional learning opportunities in the classroom.

Although high-quality external professional development is essential, it is not sufficient to change teacher practice (Cobb & Jackson, 2015). In order to make significant changes as a result of professional development teachers need opportunities where they can learn what works under certain circumstances in the classroom, examine this, then reflect on their practice (Darling-Hammond & McLaughlin, 1995; Hunter et al., 2016; Loucks-Horsley et al., 2010). Recent research on the features of high-quality professional development suggested extending support to teachers' classrooms (Cobb & Jackson, 2015; Gibbons & Cobb, 2017; Higgins & Parsons, 2011) in the form of teacher collaboration and one-on-one coaching (Gibbons & Cobb, 2017) as a valuable way for teachers to learn.

Gibbons and Cobb (2017) found four "potentially productive coaching activities" (p. 411) suitable to use when working with groups of teachers. Potentially productive activities can be defined as activities in which the teacher co-participates with a leader, in this case a School Mathematics Leader. The four activities involved: engaging teachers in the discipline of mathematics; examining student work from teachers' own classrooms; analyzing video from classrooms; and engaging in lesson study grounded in teachers' classroom practice. Co-teaching and modeling instruction were two "potentially productive coaching activities" (p. 412) found to be valuable when identifying possible ways mathematics Leaders could support individual teachers in the development of high-quality instructional practices (Gibbons & Cobb, 2017).

Several studies (Dillon, Ollerton & Plant, 2012; Feiman-Nemser, 1998; Gibbons & Cobb, 2017; Higgins & Parsons, 2011; Hunter et al., 2016) have highlighted the advantages of School Mathematics Leaders working alongside teachers. This practice is also frequently referred to by researchers as co-teaching (Eden, 2018; Feiman-Nemser, 1998; Gibbons & Cobb, 2016; Gibbons & Cobb, 2017; Graziano & Navarrete, 2012; Murphy & Scantlebury, 2010) and can be defined as, “two or more teachers teaching together, sharing responsibility for meeting the learning needs of students and, at the same time, learning from each other” (Murphy & Scantlebury, 2010, p. 1). The advantage is that both the teacher and the School Mathematics Leader are able to share the same experiences and engage in conversations about the instruction and the learning. The School Mathematics Leader and the classroom teacher can discuss what happened during the lesson, what should have happened, and discuss how to improve the teaching and learning (Gibbons, 2013). Both teachers can then analyse specific aspects of the lesson and critically reflect on the teaching and learning (Gibbons, 2013).

Working alongside teachers or co-teaching is seen as valuable. Researchers (Campbell & Malkus, 2011; Gibbons & Cobb, 2017; Jackson & Cobb, 2012; Lave & Wenger, 1991; Roth & McRobbie, 1999) who examined ways in which teachers learn have “emphasized the importance of participating in practice with a more knowledgeable other” (Gibbons & Cobb, 2017, p. 420). Teachers learn as they work alongside experts, in the case of this study, the School Mathematics Leaders, who “have acquired extensive knowledge that affects what they notice and how they organise, represent, and interpret information in their environment” (Bransford et al., 2000, p. 31).

Gibbons (2013) wrote that “there is no other way of mastering the fundamental principles of practice than by practicing it alongside a more experienced other who applies precepts and provides assurance, reassurance, and corrective feedback” (Bourdieu, 1992, as cited in Gibbons, 2013, p. 35). The date of this quote implies this idea is not something new to teacher learning. The term *working alongside* teachers has been used by various researchers and can be found in the literature (Darling-Hammond & McLaughlin, 1995; Gibbons, 2013; Gibbons & Cobb, 2017; Gibbons, Kazemi & Lewis 2017; Higgins & Parsons, 2011; Hunter et al., 2016; Osborn & Black, 1994; Putnam & Borko, 2000; Roth & McRobbie, 1999). The term was also used by Millett (1998) when referring to the four levels of increasing demand in the school mathematics coordinators role, where the term “critical friend - working alongside other teachers in the classroom” (Osborn & Black, 1994, p. 27, as cited in Millet, 1998, p. 238) was used. Corbin and colleagues (2003) also used the term in a similar way in their work which focused on the way School Mathematics

Leaders worked as a critical friend alongside colleagues in the classroom (Osborn & Black, 1994, as cited in Corbin et al., 2003).

In a recent study in New Zealand, Hunter and colleagues (2016) described how teachers often learnt “in the moment” as they taught mathematics lessons and found the actions and prompts when working alongside an experienced mathematics Leader, or mentor, caused reflective change. This practice supported the transformation of pedagogical mathematical practices. In another more recent study along similar lines, Eden (2018) described how teachers shared practice and co-taught lessons together. Eden (2018) found that resources used to support students and teachers were expanded, productive relationships were built, and trust within the relationship was strengthened. As a result of shared practice, learning-focused conversations occurred that challenged aspects of teachers’ practices, affirmed effective practice, and had the necessary potential to transform the teaching and learning of mathematics in classrooms (Eden, 2018). To ensure ongoing learning takes place, teachers need their current practice challenged, while being supported to make changes in an environment that offers both trust and challenge (Eden, 2018; Timperley, 2008; Timperley et al., 2020). This learning involves change and change involves risk, therefore, before teachers are willing to take on that risk, they need to trust their efforts will be supported (Timperley, 2008; Timperley et al., 2020).

According to the literature (Gibbons & Cobb, 2017; Jackson & Cobb, 2013) situating teacher learning within the classroom holds promise. However, Putnam and Borko (2000) assert that more research is needed to understand the dynamics of wide-ranging approaches to teacher learning. These researchers suggest that “having researchers or staff developers spend significant amounts of time working alongside teachers is not practical on a wide-spread basis” (p. 6) due to the expense involved. Putnam and Borko (2000) also made the point that although the classroom is a powerful environment in which to learn, some of the patterns and actions of teachers have become automatic and resistant to change. These authors suggest that engaging in learning experiences away from the school setting may be necessary to help teachers see things in a new context. Putnam and Borko (2000) suggest that maybe a combination of approaches in a variety of contexts possibly “holds the best promise for fostering powerful multidimensional changes in teachers’ thinking and practices” (p. 7).

While two interrelated elements of professional learning and development have been considered, external and classroom-based support, a focus on situating teacher professional learning in communities of practice or professional learning communities will now be discussed.

2.13 Professional Learning Communities Defined

Over the last 20 years the concept of professional learning communities has become increasingly popular in the school improvement literature (AITSL, 2017; Du Four, Du Four, Eaker & Many, 2010; Clarke, Faragher & Gaffney, 2014; InPraxis Group, 2006; Talbert, 2009). Although a number of terms have been used to describe the concept, such as *community of practice, learning community* and *professional communities of learners*, the terms typically refer to a similar concept and have common attributes (InPraxis Group, 2006). Most definitions describe the concept of a professional learning community as “a group of professionals who focus on learning within a supportive, self-centred community” (InPraxis Group, 2006) which is the definition used in this study.

2.13.1 Community of practice.

According to Bransford and colleagues (2000), developing communities of practice creates opportunities for teacher collaboration and learning. Likewise Lave and Wenger’s (1991) theory of learning suggested that learning occurs in a community of practice. Lave and Wenger (1991) proposed an early model of learning that showed learning situated in the context of social and cultural activities that incorporates a process they called “legitimate peripheral participation” (p. 34), where over time newcomers become full participants in a sociocultural practice (Lave & Wenger, 1991). It was proposed that through co-participation in communities of practice teachers professional learning was enhanced. Lave and Wenger (1991) believed learning that occurs through interaction and engagement “in practice, rather than being its object, … may well be a *condition* for the effectiveness of learning” (p. 93, emphasis in original). These authors viewed learning as “participation in an activity system about which participants share understandings concerning what they are doing and what that means in their lives and for their communities” (p. 98). To become a full member of a community of practice “requires access to a wide range of ongoing activity, old-timers, and other members of the community; and to information, resources, and opportunities for participation” (Lave & Wenger, 1991, p. 101). Learning was seen as a process of participation in the community of practice, where newcomers were transformed into old-timers, whose changing knowledge and skills became part of a developing identity, and in turn they became “a member of a community of practice” (Lave & Wenger, 1991, p. 122).

2.13.2 Professional learning communities.

The term *professional learning communities* as opposed to communities of practice was used by many authors (AITSL, 2017; Cobb & Jackson, 2011; Du Four, 2004; Du Four et al., 2010; Fullan, 2002a, 2002c; Fullan & Hargreaves, 2016; Fullan & Quinn, 2016; Hattie 2012). According to Du Four et al., (2010), a professional learning community refers to the larger organisation rather than the individual teams of which it is comprised. A professional learning community is "composed of collaborative teams whose members work interdependently to achieve common goals for which members are mutually accountable" (Du Four et al., 2010, p. 11). Du Four et al., (2010) described professional learning communities as "an ongoing process in which educators work collaboratively in recurring cycles of collective inquiry and action research to achieve better results for the students they serve" (p. 11).

In a professional learning community, teams of teachers gather evidence of student learning, then discuss and develop strategies. Ongoing discussion among teachers is essential as it is the key to analysis and communication of ideas which builds on strengths, and addresses weaknesses (Darling-Hammond & Ball, 1998). Teachers then implement these ideas and analyse the impact and effectiveness of them (Darling-Hammond & Ball, 1998). The professional learning community model is a powerful way of working together to focus on student learning rather than the teaching, and according to Du Four et al., (2010) it offers "the most promising strategy for meeting the challenge for helping all students learn at high levels" (p. 9).

The literature emphasises the impact that teachers working together collectively in teams can have on student and teacher learning (Hattie, 2012; Du Four et al., 2010). However, while professional learning communities are prevalent in schools, not all have been effective, and the implementation in some cases has lacked depth (Fullan & Quinn, 2016). According to Fullan and Quinn (2016), teachers need deeper collaborative experiences built on teacher input and choice, connected to their daily work of designing and assessing tasks that have the power to influence student learning.

Of particular importance to this study is the role the School Mathematics Leader plays when the focus is on mathematics. Cobb and Jackson (2011) pointed out "the importance of leadership for professional learning communities in setting the agenda, initiating and guiding activities, and enacting routines of interaction" (p. 16). The School Mathematics Leader would be the most likely candidate to provide this leadership.

According to Fullan (2002a, 2002c), the role of leadership is crucial to any school improvement, particularly professional learning communities. Although Du Four et al., (2010) pointed out that it is the principal who creates the conditions to allow the professional learning community to flourish, developing leaders within the professional learning community, including the School Mathematics Leader, and working together to achieve common goals leads to school improvement.

2.14 Concluding Comments

In summary, relevant literature has been reviewed in this chapter. The theoretical framework described how leadership and teacher learning were connected for the purposes of this study. The underlying themes related to mathematics leadership and teacher learning were reviewed and presented. The importance of mathematics and knowing how to teach it were described. Models of school leadership and effective school leadership were reviewed, followed by a definition of School Mathematics Leadership. Next there was a discussion of some of the challenges and successes experienced by School Mathematics Leaders as they appeared in the research literature, followed by a discussion of teacher mathematical knowledge, and the need to develop this knowledge. This was followed by an outline of how teachers learn. Teacher learning was a significant part of this study, as was teacher professional learning and development. This led to a distinction between teacher professional learning and professional development, and a discussion of the ways in which it could be effective. Potential opportunities for teacher learning beyond the school and within the classroom were raised and discussed. Finally, the concepts of communities of practice as distinct from professional learning communities were outlined, with details of how these might impact on teachers' ability to learn.

Chapter 3: Methodology

The purpose of this chapter is to outline the research design of the study. To begin, the philosophical assumptions and motivation for conducting this research will be described. The overall approach of the methodology and design of the research will be outlined, including details of how participants were selected, and an explanation of each phase of the study, including methods of data collection and analysis. Finally issues of ethical stance, limitations, and validity and reliability are also described.

The methodology of this study was determined by the purpose of the research, the research questions the study sought to answer, the context, and a review of the literature. While the research questions asked for the exploration of a central phenomenon, which in this case were the ways in which School Mathematics Leaders supported the professional learning of teachers, they also organised the project, gave it direction and coherence, and determined the boundaries and the focus (Punch, 2014). The use of empirical data played a central role in answering each of the research questions (Punch, 2014). As a reminder, the research questions are restated below.

The central research question was:

- How do School Mathematics Leaders support primary teachers' professional learning?

The subsidiary research questions, also listed in Chapter 1, are presented here again:

- What challenges and successes do School Mathematics Leaders report when supporting primary teachers' professional learning?
- What challenges and successes do School Mathematics Leaders experience as they build professional learning communities?

Underpinning the research questions were my beliefs and philosophical assumptions related to this study which I will now discuss.

3.1 Interpretive Paradigm

The purpose of this study was to answer the research questions which were motivated not only by my belief in the importance of the School Mathematics Leader role, but also by my philosophy of how teachers learn, and my opinions about the possible support School Mathematics Leaders can provide to teachers. In planning a study, it is important that a researcher considers their own beliefs and the philosophical worldview assumptions they bring to the study and make decisions about methods and procedures based on these assumptions (Creswell, 2007, 2009; Merriam, 1998a). As a means of understanding the ways in which School Mathematics Leaders supported teachers while working in the role, it was necessary to explore the lived experiences of the School Mathematics Leaders. This study sought to understand the specific contexts in which School Mathematics Leaders supported primary teachers' professional learning, in order to understand the meanings they bring to the situation, and to make sense of their experiences (Creswell, 2007, 2009; Punch, 2014). Meaning was also sought through the observation of discussions and interactions of School Mathematics Leaders with teachers in their schools (Creswell, 2009). This study was interpretative research, as it focused on specific contexts in which School Mathematics Leaders worked and lived and relied "as much as possible on the participants' views of the situation" (Creswell, 2007, p. 20). Information gathered from the data collected was used to generate meaning (Crotty, 1998) and to document the ways in which School Mathematics Leaders supported the professional learning of their colleagues in the teaching and learning of mathematics in primary schools.

It was important in my role as an interpretative researcher to recognise and acknowledge that my background and personal experiences as a School Mathematics Leader could shape my interpretation of how others see their world (Creswell, 2007, 2009). My aim was to empower the School Mathematics Leaders to share their beliefs and views, and my intention was to understand and interpret the ideas the School Mathematics Leaders had about their world (Creswell, 2007).

Interpretive research concentrates on the meanings people bring to a situation, and is closely aligned with qualitative methods (Punch, 2014). Qualitative methods are used when we want to understand an issue or participants views of a situation (Creswell, 2007). In the case of this study, it was the views disclosed by the School Mathematics Leaders, through their words and actions, about the ways in which they supported teachers to learn more about the teaching and learning of mathematics. This study was primarily concerned with the processes performed by the School Mathematics Leaders, the meaning these leaders intended to develop around teacher learning, as well as their understanding and interpretation of the situation (Merriam, 1998a), therefore it was interpretive research using qualitative methods.

The beliefs or worldview assumptions I had as a researcher influenced and shaped the research design, strategies of inquiry, specific methods of data collection and analysis, as well as the interpretation of the data (Creswell, 2009). These assumptions will be elaborated on later in this chapter.

3.2 Research Design

Qualitative research method was chosen for this study because it enabled exploration of the ways in which School Mathematics Leaders supported teachers' professional learning. In this study, it was the reflective descriptions and accounts of the School Mathematics Leaders work that were of interest, because they provided insights into the mathematics leadership role that each held in their primary school. In order to gain a deep understanding of the ways in which School Mathematics Leaders supported teachers to learn the knowledge and skills for effective teaching of mathematics, and to interpret what was found, it was necessary for me to become immersed in the school environment. Creswell (2007) made the point that qualitative research is used when researchers want to explore a problem or an issue and understand the context and setting in which this occurs. Qualitative research is used when the researcher is interested with meaning and how people make sense of their world, their experiences, and how they interpret them (Merriam, 1998a). It was the School Mathematics Leaders' interpretations of their role that provided insights and informed the findings of the present study.

The qualitative research design was a combination of two types, case study, a common qualitative research method, together with open coding procedures, which were used for data analysis (Yin, 2016). There are many different types of qualitative research design that help us understand the meaning of social phenomena (Merriam, 1998b; Punch, 2014; Yin, 2016). Yin (2016) lists twelve variants of qualitative research and suggests that it is possible to "use a mixed label" (p. 66) and conduct qualitative research using one of the variants such as case study. Punch (2014) echoed similar thoughts in relation to qualitative research, while Merriam (1998b) listed five types of qualitative research "commonly found in education - the basic or generic qualitative study, ethnography, phenomenology, grounded theory and case study" (p. 11). Merriam (1998b) also suggested it is possible to combine case study with any of the other types of qualitative research. It was evident that a qualitative case study using open coding procedures was the most suited strategy for the present study, as it allowed the subject of interest to be studied in its actual context, ensured the research questions were answered and the purpose of the study was achieved.

3.3 Overview

This study was designed as qualitative research and was completed over ten months in two parts. Phase 1 was a survey, and Phase 2 consisted of the case studies, which involved observations and interviews. Each of the phases and the overall research design and sequence of events is depicted in Figure 3.1.

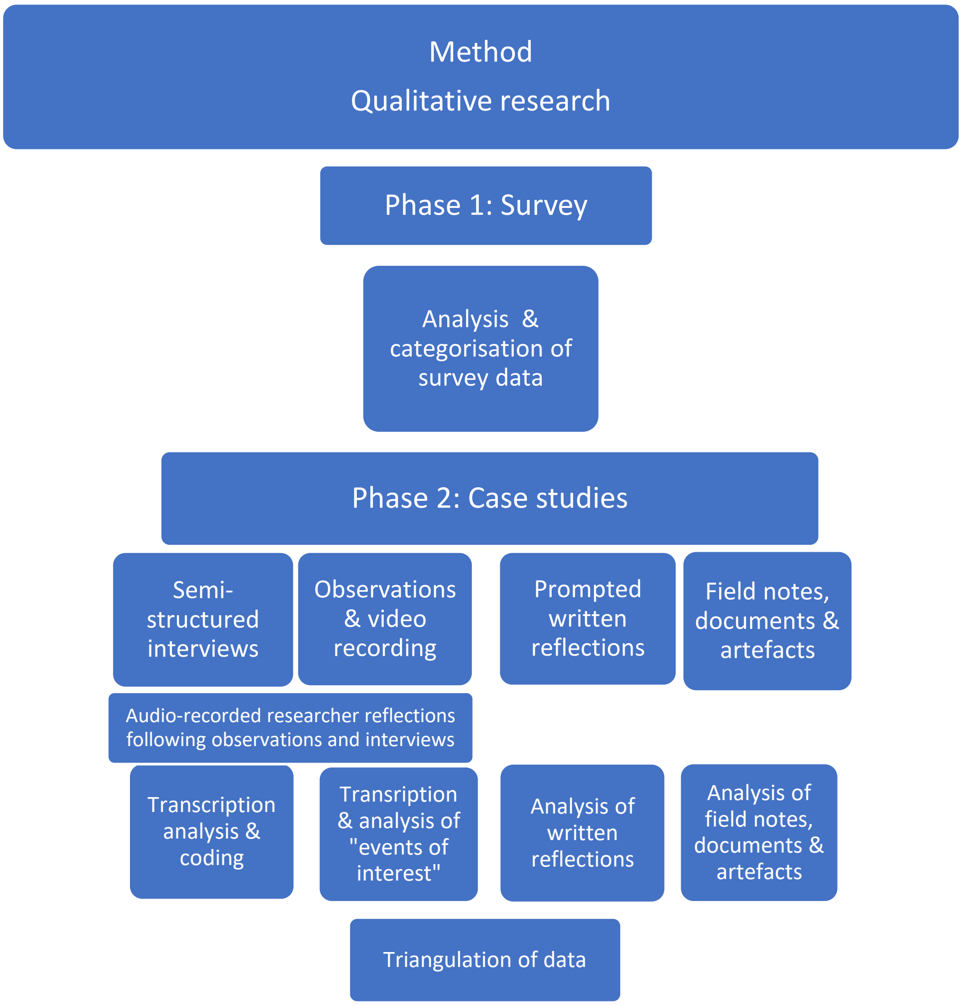

Figure 3.1. An overview of the research design used for this study.

The study began with Phase 1, the survey, which enabled the selection of participants for the case studies in Phase 2.

3.3.1 Phase 1: Survey.

A survey as a questionnaire, as opposed to survey research as a genre, was used to begin to gather information for this study (Merriam, 1998a). The online survey (see Appendix B) was created based on the literature related to primary School Mathematics Leadership and my personal experience. The survey was designed and implemented for three main purposes:

1. To gain an overall picture of the current nature of the School Mathematics Leader role,

2. To obtain a sense of School Mathematics Leaders' perception of the challenges and successes of their work, and

3. To gather data about individual School Mathematics Leaders as a means of selecting participants for individual case studies.

Following ethics approval from Monash's University Human Research Ethics Committee (see Appendix J) and the Victorian Department of Education and Training (see Appendix K), the survey was piloted by two colleagues to reveal whether School Mathematics Leaders could understand the directions and provide answers to the questions (Fink, 2017). Questions were refined based on feedback to the draft survey and consultation with supervisors. The final survey questions were designed to inform the research questions.

The questions were informed by issues arising from the research literature (Millet & Johnson, 2000). There were twenty-three questions in total, which included multiple choice, yes, no answers, as well as the ability to record text. Eleven questions were multiple choice, while nine questions had the option to add more detail and three questions were open response. Demographic data collected in the survey included: the name and location of the school in which the School Mathematics Leaders worked; the number of students enrolled at the school where the leaders worked; the number of teachers at the school; the number of years of teaching experience of each School Mathematics Leader; the number of years each School Mathematics Leader had been leading mathematics; whether or not the School Mathematics Leaders were members of the leadership team; how many hours a week were spent implementing their role; time release allocated to the role; and details of additional responsibilities. A further question asked School Mathematics Leaders to rate their perceived view of principal support out of ten. Three open-response questions provided School Mathematics Leaders with the opportunity to expand on ways they felt they supported teachers: some of the challenges they had experienced; and some of the achievements they felt were significant.

Qualtrics was used to create the survey (see Appendix B), a platform that allows a variety of question formats to be used, and data to be presented in a range of visualisations. (See Appendix C for an example of a survey response visualisation). Qualtrics was used for this study because of reliability, ease of implementation, and the ability to distribute the survey widely. Another advantage of presenting a survey on Qualtrics is the speed in which the data becomes available.

3.3.1.1 Selection of participants.

Contact was made with the Victorian Department of Education, and with its support, the survey was distributed to all four cohorts of the Victorian Government's *Primary Mathematics Specialists* (DEECD, 2013a, 2014; DET, 2017a). The cohorts included: The National Partnerships Mathematics Specialist Initiative 2010-2012, the first cohort of the *Primary Mathematics Specialist* program 2012-2013, the second cohort from 2014-2015 and the third cohort from 2016-2017 (DET, 2017a). Although the level of experience of these teachers varied, as they had been recommended for the *Primary Mathematics Specialist* teacher role by leaders within their schools, they fulfilled the criteria and were included as School Mathematics Leaders. The survey was also sent to School Mathematics Leaders recommended by experienced people in mathematics education, such as university staff, consultants, leading teachers or principals, and contacts within various schools, universities and related organisations. An email with an explanatory statement and a link to the survey was sent to each participant.

To gain a wider perspective of the role it was considered important to gather data from a range of different size schools, schools whose students were from different socio-economic backgrounds, as well as schools from a variety of regions across the state of Victoria.

3.3.1.2 Data collection.

Survey data were collected online between August and November 2016. The survey was easily accessible via email and took approximately 15 minutes to complete. The survey was completely voluntary with 20 multiple-choice or short response options and three open-response questions. A total of 56 School Mathematics Leaders responded to the survey. Forty-eight participants were female and eight were male.

3.3.1.3 Data analysis.

Informal data analysis of the survey occurred as data were being collected and as the survey was still in progress. This informal analysis allowed me to get a sense of the adequacy of the data (Yin, 2016). As the collection period concluded, the responses were compiled and sorted and formally arranged into a data base on Qualtrics, a necessary prelude to more formal analysis. Discrete data were graphed using the functions on Qualtrics (see Appendix C for an example). Next all data were downloaded into a Word document. Responses from the three open-response questions were viewed, printed and then cut and sorted into frequently occurring themes as a starting point in the analysis. The disassembling process began by making comparisons and looking for similarities and differences between responses. The categories that became clear included, mathematics planning, professional learning/development, time, budgets and resources, assessment and data, teacher resistance, working in classrooms, teacher mathematical knowledge for teaching and School Mathematics Leader confidence (see Appendix N).

Following the initial compilation of responses from the 56 School Mathematics Leaders for the three open questions, further analysis occurred. Paper copies of responses for each question were used and categories were colour coded by hand. This information was added to an Excel spreadsheet which allowed for calculations of specific responses to be made. The number of coded responses for each category were recorded. It became apparent that some of the responses throughout the three questions addressed more than one category, for example, the following response from question 23 related to achievements was coded as, assessment and data and also mathematical knowledge for teaching. This example from Participant 5 illustrates this point.

> Introduced whole school maths moderation twice a term to narrow teacher judgement and discover any misconceptions our students may have. [Participant 5]

A series of categories was generated from these responses and is presented in Chapter 4, Table 4.8. The letters (nr) indicate the total number of coded responses for each category in questions 21, 22 and 23.

3.3.1.4 Further analysis of the School Mathematics Leaders' responses.

As analysis of the data from the three open questions progressed, it became necessary to move to a higher conceptual level of codes. The description of more specific levels of coding led to further linked sub-categories and allowed for a more detailed review and analysis of the specific responses. For the purposes of this study responses were segmented into a smaller set of associated ideas (Creswell, 2007) and added into the sub-categories or groupings. This process of analysis allowed responses to be partitioned into ideas when there was "a distinct shift or change in topic" (Jacobs, Yoshida, Stigler, & Fernandez, 1997, p. 13). The number of **ideas** using open coding were collated in addition to the number of **responses**, to examine specific themes and patterns that began to emerge. Conclusions were drawn to capture the significance of the data (Yin, 2016) and were discussed as part of the survey results in Chapter 4. An example from question 21 illustrates the coding of ideas:

> I source Professional Development and liaise with Cluster Maths Leaders, plan PD sessions for staff meetings. [Participant 43]

This response was seen as two ideas. Coded in the category of professional learning, the first idea was coded into the sub-category of 'organise professional development for staff' and the second idea was coded into another sub-category 'present professional learning/ professional development' as can be seen in Table 4.12. As these responses were seen as two distinct ideas they were separated and coded as such.

There were also times when it was necessary to code multiple ideas from an individual response from a School Mathematics Leader into the same sub-category. The following example from question 22 illustrates this point:

> Finding time to work and plan with teachers. Time to provide PD to staff. Time to model best practice. [Participant 43]

This example was coded in the category of time as three distinct ideas for the sub-category of 'time to work with teachers' as can be seen in Table 4.18.

Information gathered from the survey provided an indication of mathematics leadership priorities at the time and painted a background picture by establishing a general context for the detailed case study of individual School Mathematics Leaders.

Results from the survey informed the selection of the four School Mathematics Leaders who were identified for the case studies in Phase 2 of the research, which is reported in Chapter 5.

3.3.2 Phase 2: Case study.

Case study design was selected as the most appropriate method for this research. Case study was selected as it allowed an in-depth investigation of a contemporary phenomenon within its real-life context (Yin, 2009). In this study, the practices of School Mathematics Leaders working in schools was the phenomenon under investigation. Initially it was important to identify the case and define the boundaries. Given that the study was focused on the experiences of School Mathematics Leaders, the boundaries in this study included the number of School Mathematics Leaders, as well as the time frame during which observations and interviews occurred, and prompted written reflections and artefacts were collected. This echoes the work of Yin (2009), who said that a case study approach investigates real-life phenomenon within a bounded system, involving multiple sources of evidence.

The purpose of this study was to examine the complex nature of the School Mathematics Leader role, and "to uncover the interaction of specific factors characteristic of the phenomenon" (Merriam, 1998a, p.10) which I found intrinsically interesting. Case study was selected to gain a better understanding of the ways in which School Mathematics Leaders supported teachers to learn more about the teaching and learning of mathematics. The focus was on examining a particular issue to gain a broader understanding of the case itself (Creswell, 2014). In this way, this study can be seen as an intrinsic case study.

A distinction needs to be made between an intrinsic, instrumental and collective case study (Creswell, 2007). An intrinsic case study, used in this research, is where the focus is on the case itself. This is in contrast to an instrumental case study, which focuses on one bounded case or issue, or a collective case study, that concentrates on multiple programs (Creswell, 2007). An intrinsic case study seeks to achieve an understanding of a particular phenomenon due to the researcher's intrinsic interest (Creswell, 2007; Stake, 1994). As a researcher, I was interested in collecting a variety of evidence in an attempt to understand the ways in which School Mathematics Leaders supported teachers to learn, as well as the successes and challenges they experienced. Data were collected in school settings where participants, the School Mathematics Leaders, experienced the issue under study (Creswell, 2007). While immersion in the school environment allowed interpretation of behaviour across a range of social situations (Thomas, 2016).

The decision to choose a qualitative case study stemmed from an interest in exploring and discovering more about a particular aspect of the School Mathematics Leader role, focusing on insight and interpretation, with an emphasis on description and analysis of a phenomenon (Merriam, 1998a). Merriam outlined four characteristics that are "essential properties of a qualitative case study: particularistic, descriptive, heuristic, and inductive" (1998a, p. 11).

An important feature of the *particularistic* nature of case study is that it can focus on a particular situation or program (Merriam, 1998a), which in this case was the work of School Mathematics Leaders. Having this capability made case study a particularly good design for examining situations or practical problems that arose from the everyday practice of the School Mathematics Leaders (Merriam, 1998a), and suited the context of this study.

The *descriptive* nature of case study suggested that detailed descriptions of the experiences of the School Mathematics Leaders were possible (Merriam, 1998a). As a result of this study, "a rich, *thick* description of the phenomenon under study" (Merriam, 1998a, p. 11, emphasis in original) was completed, as well as a description and analysis of related situations and events. This approach added to the body of knowledge about the topic and increased understanding of the important role School Mathematics Leaders played in supporting teachers to learn. Detail was achieved through in-depth analysis of observation notes, video-recorded meetings, audio-recorded interviews, prompted written reflections and documents and artefacts.

Importantly, *Heuristic* case studies suggest that insights into the topic under study are gained "into how things get to be the way they are" (Stake, 1981, p. 47), new meanings are discovered, experiences extended, and some confirmation of what was known occurs (Merriam, 1998a). This approach encourages explanation of "the background of a situation, what happened, and why" (Merriam, 1998a, p. 14).

Over the course of the study, the process of studying the four cases led to new discoveries about ways School Mathematics Leaders supported teachers to learn and contributed to a better understanding of conditions that enhanced this support. Using this *inductive* approach, is a further essential property of a qualitative case study. Merriam (1998a) stated that "for the most part, case studies rely on inductive reasoning" (p. 13).

There was no hypothesis or theory to test, instead "generalisations, concepts, or hypotheses emerge[d] from an examination of data—data grounded in the context itself" (Merriam, 1998a, p. 13).

This case study was by definition an interpretative case study. Evidence related to the ways in which School Mathematics Leaders supported teachers' professional learning was gathered with the intent of "analysing, interpreting, or theorising about the phenomenon" (Merriam, 1998b, p. 38). Throughout the study descriptive accounts of the cases of particular School Mathematics Leaders were provided with the purpose of interpreting the ways in which they supported teacher learning. Interpretative inquiry assumes "an in-depth understanding and deep immersion in the environment of the subject" (Thomas, 2016). Thomas (2016) noted that case study and interpretative inquiry complement each other, as each demands a deep understanding of the nature of social situations. According to Merriam (1998a), "in reality, most case studies are a combination of description and interpretation, or description and evaluation" (p. 35). The present study was more description and interpretation. The case study approach enabled accounts of the work of the School Mathematics Leaders to be told through the detailed analysis of evidence.

I have outlined the research design and provided an overview of the study. I have also described the ways in which the survey and case study participants were selected. An explanation of the survey data collection methods used was provided, as well as how the data were analysed. Next, I will describe the data collection methods and analysis that took place in the case studies.

3.3.2.1 Selection of participants for case studies.

As the focus of this study was an investigation of the ways School Mathematics Leaders worked to support teachers, the selection of participants was critical to the research. Following the survey, four experienced primary School Mathematics Leaders were selected to participate in the case study through purposive sampling (Krathwohl, 1998; Merriam, 1998a). The number of participants was limited to four following a recommendation of the university confirmation panel. Purposive sampling was chosen because it allowed a range of perspectives on the subject which could yield information rich data (Yin, 2016). In this study, data on effective ways to support primary teachers to learn more about the teaching and learning of mathematics was sought. Purposeful sampling is based on the assumption that the researcher wants to gain insight, therefore "needs to select a sample from which one can learn the most" (Merriam, 1998a, p. 48). Participants were required to match certain criteria before they could be included in the case studies (Merriam, 1998a).

The following criteria were considered as participants were selected. Participants were chosen from a range of different sized government primary schools in metropolitan regions of Victoria. Participants needed to understand their role and be able to draw upon a number of years of experience, compared to "newcomers" in the role (Lave & Wenger, 1991). The case study participants needed to have established themselves in their school and were chosen based on experience in teaching and leading. In the words of Bransford et al. (1999), they were experts who had "acquired extensive knowledge that affects what they notice and how they organise, represent, and interpret information in their environment" (p. 31). Participants also needed to be experienced in mathematics leadership with the potential to lead teacher learning in mathematics education.

Throughout the selection process, several names reoccurred from the broader pool, and were recommended as being well respected in the field of mathematics education and leadership in schools. After sorting and grouping the responses, the selected participants were emailed and asked to be part of Phase 2 of the study, the case studies. In total thirteen School Mathematics Leaders matched the selection criteria and were invited to participate in the second phase of the study, four agreed. The School Mathematics Leaders who declined, stated they were unable to commit due to demands of their current teaching role or personal reasons. The final four participants were all female and provided a contrast in terms of roles, responsibilities and experiences. Table 3.1 outlines details of the roles and responsibilities of each participant.

Table 3.1

Roles and Responsibilities of Case Study Participants

Participant pseudonyms	Identified role within their school while working as a School Mathematics Leader	Responsibilities during 2016 / 2017
Susan	Mathematics coach	Attended and supported all Year level teams in planning mathematics Coached teachers on a needs basis No timetabled classroom teaching time Organised mathematics professional learning team meetings Member of school leadership team
Jane	Teaching and Learning Leader/ Leading Teacher/ Teaching support in Foundation classrooms	Attended and supported 2 Foundation level teams in weekly planning Began in a mathematics coaching role Taught 8 hours per week in Foundation classrooms Organised mathematics professional learning team meetings Member of school leadership team
Amy	Mathematics mentor/ Primary Mathematics Specialist	Worked with specific teachers in planning of mathematics lessons and in classrooms mentoring, team teaching and modelling Attended mathematics professional learning team meetings Not a member of school leadership team
Robyn	Classroom teacher/ Year 3/4 level Team Leader	Initially full-time classroom teaching role then became part time Allocated 1 day a week for mathematics mentoring, team teaching and leadership during the second year of the study Organised mathematics professional learning team meetings Member of school leadership team

Each of the case study participants roles and responsibilities differed as they led mathematics in their schools. Three of the four School Mathematics Leaders were members of the school’s leadership team and organised professional learning team meetings. While all four School Mathematics Leaders eventually had dedicated time release to enact their role, it was not until the second year of the study that one School Mathematics Leader, Robyn, was provided with dedicated time release to lead mathematics.

To allow for a comparison between case study participants, it was decided to select at least one participant, Robyn, an experienced School Mathematics Leader who fulfilled the role with full-time classroom-teaching responsibilities when the study began. Jane was chosen because she worked part-time in the classroom and part time in a coaching role.

While Amy was selected because she worked in a mentor role and was a trained *Primary Mathematics Specialist*. Finally, Susan was selected as she worked as a full-time coach without any specific classroom teaching responsibilities. Each participant led mathematics in their school as a School Mathematics Leader, the term used throughout this study.

While the selected School Mathematics Leaders were not representative of the role, their varied position descriptions provided different contexts for School Mathematics Leadership.

3.3.2.2 Meeting case studies participants.

Before commencing Phase 2 of the study (Case Studies), I met with each of the participants at their schools to explain the nature and purpose of the study, my role as an observer and interviewer, and the ways in which each School Mathematics Leader could contribute towards the project. School Mathematics Leaders, teachers and principals were all provided with the approved explanatory statement and consent forms to sign. This initial meeting also provided the opportunity to begin to establish a trust relationship with the case study participants before the observation and interview collection period began. It was important to "establish rapport by paying homage to the participants' routines, establishing what the observer has in common with the participants, helping out on occasion, being humble, and showing interest in the activity" (Merriam, 1998a, p. 91). It was also particularly important to explain the research and answer questions or concerns at this time.

During this meeting the prompted written reflection format (see Appendix H) was also explained. As part of the data collection approach, participants were invited to complete a prompted written reflection, which allowed them to describe an incident or significant event during the course of the data collection stage. Options for implementation, including preferences for email or computer software were discussed at this meeting. A date and time for the first observation and interview visit, which occurred on the same day, were also organised.

3.3.3 Case study approach.

Observations and interviews of the case study participants as well as the collection of prompted written reflections took place over a 10-month period, from September 2016 to June 2017. Several observations and interviews began concurrently as the survey was still in progress (see Appendix A which includes the interview and observation timeline). This was possible because of the availability of several of the School Mathematics Leaders. It was also important to take advantage of the timing and to gather data within the school calendar year, where possible.

3.3.4 Data collection.

Six data collection methods were used for the case studies. Data included survey results, interview transcriptions, video recorded meeting observations, School Mathematics Leader prompted written reflections and researcher reflections, as well as field notes and artefacts. This allowed for triangulation of data, which is recognised as a strategy in qualitative research (Denzin, 1978). The practice of triangulation was also chosen to strengthen the credibility of the study (Yin, 2016). Yin (1984) pointed out that a unique strength of case study "is its ability to deal with a full variety of evidence-documents, artefacts, interviews, and observations" (pp. 19-20). While Merriam (1998a) also noted, multiple sources of data were a major strength of case study that allowed for triangulation, a feature of the present study.

For each participant the following data were collected:

- Responses to the online survey (Phase 1)
- Participation in 3 (in one case 4) semi-structured interviews (audio-recorded) (Phase 2)
- Observations of 3 (in one case 4) team planning or professional learning team meetings (video-recorded) (Phase 2)
- Researcher reflections following interviews and each observation (audio-recorded)
- Prompted written reflections completed by School Mathematics Leaders (between 1 and 3 each)
- Observation field notes and artefacts collected included: meeting agendas, assessment tasks, curriculum documents, planning documents, an application for mathematics related funding and examples of professional learning presentations.

Case study data were collected over a ten-month period in a cyclical process from September 2016 to June 2017. Field notes were taken relating to demographic data during the initial meeting with each School Mathematics Leader. Following the initial meeting, three of the four School Mathematics Leaders were observed and interviewed for no longer than 50 minutes on three occasions. With a change of role in the new school year, the opportunity arose to engage in a further observation and interview with the fourth School Mathematics Leader. This contributed further to the data. Interviews were audio-recorded, and as soon as possible after each observation and interview, “researcher reflections”, that provided a response to, and a summary of, the situation, were also audio-recorded as further data (Merriam, 1998a).

In three of the cases, it was necessary to continue the observations, interviews and written reflections into the following school year. Extending the time frame was necessary to fit in with the availability of the School Mathematics Leaders for interview, their meeting schedules and suitable opportunities to observe meetings. The advantage of this was that the participants did not feel pressured by the commitment and time this involved, and often had new experiences and insights to share as they began a new school year.

Table 3.2 includes the data collection methods used to answer the research questions and possible examples of data collected.

Table 3.2

Data Collection Method Matched with Research Questions and Examples of Data Collected

Research question	Data collection method	Examples of data collected
How do School Mathematics Leaders support teachers' professional learning?	Survey (Phase 1)	Background information related to the specific role including experience and responsibilities
	Observations	Interactions with teams and individual teachers
	Semi-structured interviews	Explanations of beliefs, behaviours, actions, experiences, reactions, recollections, reflective comments
	Prompted written reflections	Descriptions of actions, experiences, interactions, viewpoints, expectations
	Documents/Artefacts	Evidence of assessment, planning documents, meeting agendas, professional learning presentations and other written documents
	Researcher reflections	Audio-recorded researcher reflections following each observation and interview
What challenges and successes do School Mathematics Leaders report when supporting primary teachers' professional learning?	Survey (Phase 1)	School Mathematics Leaders views of possible challenges, successes and achievements experienced within their role
	Observations	Actions, behaviours, reactions of teachers
	Semi-structured interviews	Explanations of beliefs, behaviours, actions, experiences, reactions, recollections, reflective comments
	Prompted written reflections	Descriptions of actions, experiences, interactions, viewpoints, expectations
	Documents/Artefacts	Evidence of assessment, planning documents, meeting agendas and other written documents
	Researcher reflections	Audio-recorded researcher reflections following each observation and interview
What challenges and successes do School Mathematics Leaders experience as they build professional learning communities?	Survey (Phase 1)	School Mathematics Leaders views of how they believed they contributed to building professional learning communities
	Observations	Communication, interactions and relationships evident between teachers, contributions to meetings
	Semi-structured interviews	Explanation of beliefs, behaviours, actions, experiences, reactions, recollections, reflective comments
	Prompted written reflections	Descriptions of actions, experiences, interactions, viewpoints, expectations
	Documents/Artefacts	Evidence of assessment, planning documents, meeting agendas and other written documents
	Researcher reflections (audio- recorded)	Researcher reflections following each observation and interview

In the following section, each data collection method is described as it was used.

3.3.4.1 Observations.

The focus of the observations for this study was determined with reference to the research questions and concentrated on “certain events, behaviour, or persons” (Merriam, 1998a, p. 89). Through the observation and documentation of the practices of the School Mathematics Leaders as they went about aspects of their work, it was possible to note ways in which they supported teachers in their professional learning. Observations were made during team planning meetings, professional learning team (PLT) meetings, and, in one case, during a School Mathematics Leader network meeting, hosted by one of the School Mathematics Leaders involved in this study. All observations were completed within a ten-month period and were organised at pre-arranged times. They were observations of the regular meetings held in each school. This provided opportunities to observe behaviours and interactions in situations, or practical problems that arose from everyday practice, and opportunities to observe things that interviews might not reveal (Merriam, 1998a).

Each School Mathematics Leader was observed on three to four occasions to obtain an overall picture of the support they provided to teachers in their school (see Appendix A for the timeline). The observation also provided a context in which the School Mathematics Leaders worked and gave a sense of the various components of their role. The overall aim of the observation was to gain a sense of the ways in which each School Mathematics Leader believed they supported teachers’ professional learning and how they contributed to building professional learning communities within their schools.

3.3.4.1.1 Use of video-camera.

It was decided that the most effective method for capturing the actions, interactions and behaviours of participants was to record evidence of each observed meeting on video-camera. According to Punch (2014) there are two practical issues in planning the collection of data during observations. Firstly, establishing the focus of the observation and deciding what will be observed and why, and secondly recording the observation.

In the present study, there were several advantages of using a video-camera for recording. The use of a video-camera allowed the actions of each School Mathematics Leader and the teachers to be observed in a natural and open way and provided evidence of how events unfolded naturally (Punch, 2014). Thomas (2016) suggested that there are a number of advantages of using image-based methods, including the fact that you can capture a scene far more discreetly and effectively than you can by recorded notes. Thomas

(2016) also made the point that “image-based methods provide a powerful extension of observation and open up a range of possibilities for case study research” (p. 198).

One handheld video-camera was used to capture image and sound of all people present at each meeting. All participants were aware of the presence of the video-camera and had signed an informed consent form for its use. One primary obligation for me as the researcher was to alter the action as little as possible by my presence (Punch, 2014) and by placing a video camera in an unobtrusive place, the meeting was uninterrupted by the data collection.

According to Merriam (1998a) “the more complete the recording the easier it is to analyse the data” (p. 96). An advantage of using a video-camera was the ability to analyse the video footage in my own time, which allowed detailed analysis through continued viewing and reviewing of the video footage. The resulting transcriptions of events of interest also assisted with data analysis, as they provided a more complete picture of events (see Appendix I for an example of a transcription). In some instances, participant responses in a meeting were also counted, including the number of questions asked and periods of silence were noted.

Interviews and observations occurred during the same day of each visit in all but one instance. When this was possible, video-recorded evidence allowed comparisons to be made between the direct observation of what School Mathematics Leaders did, and what they said in their statements as recorded in the interviews. Punch (2014) recommended combining observational and interview data collection as a good qualitative research strategy. Recording the behaviour of participants was used to inform interviewing and led to “very rich, high quality data” (Punch, 2014, p. 155).

3.3.4.2 Interviews

For the purposes of this study, three semi-structured interviews (Merriam, 1998a) were conducted, with each case study participant, either prior to, or immediately following each observation at a suitably arranged time. The interviews were guided by questions related to the work of the School Mathematics Leaders and were recorded using digitised audio, then transcribed for analysis. Questions were based on four categories developed from the research literature and relevant to this study, leadership, professional learning, learning communities and reflective practice. Each School Mathematics Leader was asked the same core questions at each visit. For example, under the category of professional learning, School Mathematics Leaders were asked: What have been some of the main challenges in supporting teachers' professional learning? How have you attempted to overcome these challenges? Can you give me an example?

Each of the three interviews differed in its focus questions. (See Appendices D - G for a copy of the interview questions.) In addition, at each interview, more specific questions were asked to clarify points following observations. Follow-up questions were also asked to clarify points made in prompted written reflections or to clarify questions that arose from the researcher's reflections following prior observations and interviews. Semi-structured interviews allowed some flexibility and provided an opportunity for "the researcher to respond to the situation at hand" (Merriam, 1998a, p. 74), through careful selection of questions and prompts.

The interviews allowed the School Mathematics Leaders the opportunity to elaborate on aspects of their role and provided them with the chance to share their thoughts and experiences (Merriam, 1998a). According to Punch (2014) there are many types of interviews, however the interview type selected should be based on the purpose, the strategies and the research questions. For this study, the purpose was to encourage the School Mathematics Leaders to openly share their thoughts and beliefs based on their experiences. While Merriam (1998a) stated that "interviewing is a common means of collecting qualitative data" (p. 71), according to Patton (1982), interviewing for case study for the most part is to gain information and to find out things that "we cannot directly observe" (p. 161).

Each interview was conducted for no longer than fifty minutes. Question order and wording changed depending on the responses of the participants (Merriam, 1998a). It is acknowledged that the type of information obtained depended on a number of factors, including the personality and skill of the interviewer, and the attitude, ability and willingness of the participants to express their thoughts, opinions and feelings (Creswell, 2007; Merriam, 1998a). The choice of participant and their understanding of the topic under study also affected the quality of the interview (Merriam, 1998a). Hence, one of the reasons only participants that understood their role and who had a number of years' experience to draw upon were selected for the case studies.

A core set of questions was prepared beforehand, and others were added in a conversational style as the interview progressed. Interviews were used because they are "one of the most powerful ways we have of understanding others" (Punch, 2014, p. 144), and are "capable of producing rich and valuable data" (p.148). I was aware of the need to be a good reflective listener, and of my own preconceptions and personal biases, and how these may influence the study (Merriam, 1998a). I was also aware of the advice of Yin (2009) to be adaptable and flexible and to have a "firm grasp of the issues being studied" (p. 66). My experience as a School Mathematics Leader ensured I had a complex understanding of the issue being explored, whilst I maintained a deliberate focus on entering another person's perspective to capture the complexities of the "individual perceptions and experiences" (Patton, 1982, p. 166) of the School Mathematics Leaders concerned.

3.3.4.3 Prompted written reflections.

A series of prompted written reflections completed by the School Mathematics Leaders provided a further source of data to answer the research questions. The reflections were based on events the School Mathematics Leader believed were significant in the day-to-day enactment of their role when supporting the professional learning of teachers. The prompted written reflections were guided by several cues and could be completed at any time. (See Appendix H for the format and cues.) The reflections allowed School Mathematics Leaders to share their thoughts, reactions and interactions, and prompted them to engage in reflective practice. Prompted written reflections could be positive or negative experiences, interactions or everyday occurrences (DEECD, 2013b), and could "include commonplace events in the everyday life of the classroom" (Tripp, 2011, p. 24). Prompted written reflections were intended to reveal the way School Mathematics Leaders looked at situations and interpreted the significance of events (Tripp, 2011).

Throughout the data collection period, monthly emails were sent to each School Mathematics Leader reminding them of this data collection strategy. Although the response rate was small, the four School Mathematics Leaders completed eleven entries in total over a ten-month period. Each School Mathematics Leader recorded between one and three prompted written reflections each time, which varied in detail and length. These prompted written reflections served to enrich the data and to strengthen my findings.

3.3.4.4 Documents and artefacts.

Documents and artefacts provided an additional source of data. In the case of this study, several documents provided background information related to the School Mathematics Leader role and provided further detail of events which could not be observed

(Merriam, 1998a). Such documents included: planning documents, curriculum outlines, minutes of meetings, assessment task examples, slide-show presentations, role descriptions and an application for mathematics related funding. One of the greatest advantages in using this evidence was its stability, and the fact that it could not be influenced by the presence of the researcher (Merriam, 1998a). Although the documents were not produced for research purposes, they were particularly good as a source of evidence for the case studies, and because they were a product of the school in which they were produced, they could provide insights into the questions being investigated and were grounded in a real-world context (Merriam, 1998a).

3.3.4.5 Researcher reflections.

As a teacher and a researcher, engaging in reflective practice is something that came naturally. Following each observation and interview as I left the school, I recorded my thoughts, my impressions and any questions that occurred to me. These questions or specific points of interest were followed up by email or during the next visit. The recording of personal reflections allowed me to process what I had observed, heard, and learnt as I left the site, which then became an additional source of data. Researchers have suggested that engaging in reflective practice, is not only valuable, but crucial in nearly every profession (Absolum, 2006; Shulman & Shulman, 2004).

3.3.5 Data analysis.

Initial data analysis of the case studies involved examining the data collected from each of the four School Mathematics Leaders. Some informal analysis of the data began during the data collection stage. As Yin (2016) suggested this initial analysis helped to decide on the adequacy of the data. As the study progressed, transcripts of interviews were completed, video-recoded observations and all related documents and artefacts were added to electronic files. Through reading the transcripts, watching the videos and listening to the audio recordings, I was able to get a sense of the data and gain an impression of important ideas that were recurring.

Although data analysis for this research aligned with a grounded theory approach, for the purposes of this study, the five-phased cycle headings proposed by Yin (2016) were used for the case studies. These five phases of analysis: compiling, disassembling, reassembling, interpreting and concluding, supported the purpose of this particular study. The headings provided structure during the analytical phase, and enabled analysis to progress in a methodical manner, where I moved backwards and forwards through these iterative and recursive phases over time.

Coding of the qualitative data followed similar lines to the grounded theory approach which includes open, axial, selective, and process coding (Strauss & Corbin, 1990). These practices roughly align with the disassembling and reassembling phases used in this study (Yin, 2016), and will be explained in more detail below (see Appendix N for a detailed overview of level 1 to 5 coding).

Data analysis was systematic and transparent. The steps taken in this data analysis align with the steps outlined below using the five phases of analysis described by Yin (2016).

3.3.5.1 Compiling data.

The first formal phase began with *compiling* and sorting and formally arranging the data. Each interview was transcribed and carefully checked, pseudonyms were added and identifying factors deleted. The qualitative data were organised and compiled into an electronic file to create a database, which is an essential prelude to the data analysis (Yin, 2016). Interview transcripts were added to NVivo computer software and printed copies were made. To gain a sense of the overall meaning of the data and an impression of the depth of information, it was important to read it through and reflect on what participants were saying (Creswell, 2009). Printed copies of the interview transcripts were viewed many times, parts that seemed important were underlined and highlighted, while some initial thoughts were recorded in the margins, and many ideas were recorded in a personal notebook. Reviewing of field notes, transcripts and video-recorded observations, ensured increased familiarity with the data and provided a sense of its distinctive features. In this way insights emerged from the data (Yin, 2016).

3.3.5.2 Disassembling data using coding.

The next phase, *disassembling,* involved breaking down the compiled data into smaller pieces (Yin, 2016). Disassembling data or breaking down the data can occur in many ways. Coding by assigning tags, names or labels to the significant parts of data, is one way this occurs (Krathwohl, 1998; Punch, 2014; Yin, 2016). The coding process for this study began by reducing data “into themes and groupings through a process of coding and condensing the codes” (Creswell, 2007, p. 148). The codes were based on the two fields of research literature that informed this study, leadership and teacher learning. More codes were developed with further examination of the data (Charmaz, 2006). Initial descriptive codes were used which then moved to higher conceptual level codes (Punch, 2014; Yin, 2016).

Data analysis using printed copies of transcripts and NVivo were used simultaneously. Once the interviews were added to the computer software program, nodes and tree nodes were created. Coding was completed using the original coded paper copy as a guide and provided a cross-check and revision of the initial coding. Initial codes or nodes were created and trialled using one completed data set of interview transcriptions from one School Mathematics Leader. As the analyses continued, codes were adapted based on themes that were occurring, and a second level of category codes, or tree nodes, were created. All three interviews were completed before coding of the next set of interviews began. As ongoing analysis occurred, patterns and key issues emerged. (See Appendix L for coding used in NVivo for interview data).

There are advantages of using computer software such as in the retrieving and manipulating of the data, and with some of the features available (Yin, 2016). However, learning how to use the computer software took considerable time. During this time, it was important not to have attention diverted towards the software's operations, as according to Yin (2016), "you risk losing sight of some potentially invaluable ideas" (p. 201). This was one of the reasons paper copies of coded transcripts were also used.

3.3.5.3 Reassembling data.

The third phase of data analysis, the *reassembling phase* was the time to look for patterns. Several strategies were used for reassembling the data. This involved reorganising and reassembling the data into different categories or groupings based on the substantive themes that were emerging as the data were re-examined. Creating a matrix, (see an example in Appendix M) in this case, a two-dimensional array of rows and columns, based on themes was one specific method for reassembling the data (Yin, 2016). A copy was also printed and arranged manually onto large sheets of paper. This allowed me to scan across the rows and columns to search for meaningful patterns and look for similarities and differences while sorting ideas (Yin, 2016). An attempt was also made to use NVivo computer software for this phase, but with limited success.

As the formal coding process continued during the reassembling phase, coding levels were adjusted (Yin, 2016). Level one and level two codes moved to a higher conceptual level and themes and theoretical concepts began to emerge (Yin, 2016). For example, a level one code was implementing the role, then reflecting on the role became a level two code. This led to a level three code of, leading mathematics and a level four code of effective mathematics leadership. Reassembling the qualitative data enabled a closer examination of the evidence across cases and led to the ability to notice and highlight points of interest across all four School Mathematics Leaders, which became the basis for the next phase of interpretation. Themes from the cross-case analysis (see Appendix N) of the data became apparent and are reported and discussed in Chapter 6.

Reassembling the disassembled data in this way was a powerful way of viewing the data. It was possible to see patterns in the data that were not otherwise apparent. The reassembling phase, where large amounts of data are reorganised, according to Yin (2016), aligns with the term axial coding used in grounded theory analysis (Strauss & Corbin, 1990).

3.3.5.4 Interpreting.

The fourth phase, *interpreting* the data, involved giving meaning to the findings (Yin, 2016). During this stage, at times, it was necessary to go back to the data to recall events or participants words, rethink patterns and themes and reflect on what was found. Survey data was also linked to the case study data. As the main goal was to develop a detailed interpretation that included specific data around the main patterns and themes, the interpretation phase brought the whole analysis together. It was possible at this stage to give meaning to the findings.

3.3.5.5 Concluding.

The fifth phase, *concluding*, involved connecting the interpreting phase with the study’s main findings. In this sense, drawing conclusions from the study may still be considered part of the data analysis (Yin, 2016). The conclusion raised the interpretation of the study to higher level and captured the broader significance of the study (Yin, 2016).

While qualitative data analysis does not always follow a specific approach, and can be completed using a combination of approaches, the five-phased cycle as proposed by Yin (2016), and referred to above, provided a structured data analysis approach that suited the purpose and the overall logic of this study. (See Appendix N for an overview of coding).

3.4 Ethical Stance

This research was guided by ethical codes and regulations and followed procedural requirements of the relevant authorities. Ethics permission was obtained from Monash University Human Research Ethics Committee (see Appendix J) and the state Department of Education and Training (see Appendix K). All precautions were taken to ensure ethical practice occurred at all times. Explanatory statements were provided to the school principals, School Mathematics Leaders, and teachers involved in the teams being observed. Participants were entirely voluntary and at all times objectives of the research were communicated. Written consent was obtained from principals, School Mathematics Leaders, and teachers who were able to withdraw from the study at any time (Punch, 2014).

Protocols were established between the School Mathematics Leaders and myself in relation to the recording of observations and interviews and the use of field notes. Observations were of School Mathematics Leaders in their regular practice in schools. Care was taken not to disrupt daily routines. Participants were advised when the interviews began and were completed. Data has been stored securely over the duration of the project. Pseudonyms have been used in the case of participants and their schools. A professional ethical stance was maintained, and participants were assured of confidentiality and anonymity. “Ethical research practice is ultimately a matter of responsible situated judgement” (Punch, 2014, p. 37).

According to Punch (1994, as cited in Punch, 2014), the main ethical issues in social research are “harm, consent, deception, privacy and confidentiality of data” (p. 43). Punch also pointed out that these challenges arise in all designs and approaches in research, and at every stage of a project, “from the choice of research topic, which raises questions about the worthwhileness of the research, through to the reporting and publication stage, and beyond” (2014, p. 36).

3.5 Limitations of Case Study

Limitations and strengths are present in all research. In this particular study, the researcher was the primary person collecting and analysing the data, therefore care needed to be taken not to over exaggerate or simplify the situation (Merriam, 1998a). Readers as well as the author need “to be aware of bias that can affect the final product” (Merriam, 1998a, p. 34). Having worked as a *Primary Mathematics Specialist* and a School Mathematics Leader myself, I had a detailed appreciation of the role. I understood the complexities of the role in terms of my personal successes and challenges. However, it was the intention of this study to gain further insights into this role and see it from the perspective of other School Mathematics Leaders in school settings other than my own. I intended to identify the actions, feelings, thoughts and reflections of these leaders, observe them in their regular practice and see situations “in terms of meanings people bring to them” (Denzin & Lincoln, 2005, p.3). It was necessary to be mindful that I could be influenced by my experiences, and to mention this if it occurred. A further challenge during an interview setting was not to share personal experiences with participants, as this could have reduced and influenced the information shared (Creswell, 2007).

Finally, one further limitation could be the fact that the responses of each School Mathematics Leader during interview were based on their perceived views or beliefs of a situation, which may not always be consistent with the point of view of others. The views the School Mathematics Leaders shared were from their perspective and experience.

3.6 Validity and Reliability Issues

Validity and reliability are two major concerns in any research, as “every researcher wants to contribute knowledge that is believable and trustworthy” (Merriam, 1998a, p.183). Validity in research refers to whether an instrument measures what it claims to measure, while reliability refers to consistency or stability (Punch, 2014). To establish credibility researchers can employ a number of validation strategies. Creswell (2007) and his colleague decided to focus on eight strategies that are often used by qualitative researchers in an attempt to document the “accuracy” of their studies, namely: prolonged engagement and persistent observation; triangulation; peer-review; refining initial hypotheses; clarifying researcher bias; member checking; external audits and rich, thick descriptions. According to Creswell (2007) qualitative researchers need to engage at least two of these procedures in any study.

Throughout this study I was mindful of the situations that threatened validity and/or reliability in the research and employed a number of the strategies listed above to eliminate these. Strategies used included: triangulation of different sources of data to shed light on a perspective; clarifying researcher bias from the beginning of the study; commenting on past experiences that may impact on the inquiry; and the writing of a “rich, thick description” (Creswell, 2007, p. 208) describing in detail the work of the School Mathematics Leaders. Each of these strategies strengthened the reliability and validity of the research.

3.7 Conclusion

The research design has been presented in detail in this chapter. A qualitative case study was an effective tool "for understanding and interpreting observations of educational phenomena" (Merriam, 1988a, p. 2). The survey, observations, semi-structured interviews, prompted written reflections and analysis of documents and artefacts contributed towards providing a detailed description of the phenomena under study. These research methods were ideal for attempting to understand how the many elements worked together to describe the ways in which each School Mathematics Leader supported teachers to learn (Merriam, 1988a). For the purposes of this study, the crucial factor was the potential of the methodology to enable each School Mathematics Leader to contribute to findings that answered the research questions (Merriam, 1998a).

In the next chapter findings from Phase 1 of the study, the survey, will be presented and particular aspects of the current nature of the School Mathematics Leader role will be described. Phase 2 of the study will be reported in Chapter 5.

Chapter 4: Findings: Phase 1—Survey

Chapter 4 is the first of two chapters that seek to report on the results of this investigation into the ways in which School Mathematics Leaders support teachers' professional learning in primary schools. The results will be presented in two parts: Chapter 4 Findings: Phase 1: Survey (see Appendix B for a copy of the survey), and Chapter 5 Findings: Phase 2: Case studies. Phase 1, the survey, reports a background picture of mathematics leadership as enacted by primary School Mathematics Leaders in Victorian Government schools. Data were collected online through Qualtrics from 56 respondents over a four-month period from August 2016 until the end of November 2016. While several studies (Bell & Ritchie, 1999; Cheeseman & Clarke, 2005, 2006) point out that mathematics leadership is a challenging, complex and demanding role that combines leadership and management in a number of ways, a gap exists in the literature related to the enactment of mathematics leadership and the ways in which School Mathematics Leaders support teacher learning in schools. The purpose of this survey was to gain an in-depth perspective of the current nature of mathematics leadership.

The survey included a mix of closed and open questions. There were 23 questions in total. Questions 1 to 8 were closed questions which provided demographic information from the School Mathematics Leaders. Questions 9 to 20, excluding question 11, were designed to provide information about the specific responsibilities and the role of the School Mathematics Leaders. Question 11 allowed the School Mathematics Leaders to indicate on a scale from 1 to 10 how they perceived their principal's support. While questions 21, 22, and 23 were open questions that provided more detailed information related to successes, challenges and achievements in mathematics leadership as perceived by the School Mathematics Leaders, also described in Section 3.3.1.

4.1 Findings Related to Demographic Data

The findings which reflect the demographic make-up of the survey sample will be described next. The School Mathematics Leaders' experience, the ways in which they were allocated to their role, their teaching experience, the location and size of the school in which they work, their classroom teaching responsibilities in addition to their role, and their perceived view of their principal's support will be outlined.

4.1.1 Experience as a School Mathematics Leader.

Initially it was important to know the length of time each School Mathematics Leader had been leading mathematics. This information provided a sense of how well each School Mathematics Leader understood their role, and the number of years of experience they were able to draw upon, compared to “newcomers” in the role (Lave & Wenger, 1991).

Question eight asked School Mathematics Leaders: How many years have you been a School Mathematics Leader? Table 4.1 shows the number of years each School Mathematics Leader had led mathematics and how many of the group of 56 had previously trained or were existing *Primary Mathematics Specialists.*

Table 4.1

(Q8) School Mathematics Leader Experience

Years of mathematics leadership experience	School Mathematics Leaders (n=35)	Trained Primary Mathematics Specialists (n=21)	Total (n=56)
1–2 years	13 (23%)	7 (13%)	20 (36%)
2–3 years	7 (13%)	4 (7%)	11 (20%)
3–4 years	2 (3%)	1 (2%)	3 (5%)
4–5 years	4 (7%)	1 (2%)	5 (9%)
5 + years	9 (16%)	8 (14%)	17 (30%)
Total	35 (62%)	21 (38%)	56 (100%)

Table 4.1 shows 17 (30%) School Mathematics Leaders had been in their role for five or more years, five (9%) for four to five years, three (5%) for three to four years, 11 (20%) for two to three years and 20 (36%) for one to two years. Of the group of 20 (36%) School Mathematics Leaders, seven (13%) were new to leading mathematics and were also part of the state government *Primary Mathematics Specialist* (DEECD, 2013a, 2014) program. The five School Mathematics Leaders with two to four years’ experience would have just completed the two-year training. While nine School Mathematics Leaders with four years or more experience had previously trained as part of the *Primary Mathematics Specialist* (DEECD, 2013a, 2014) program and continued to lead mathematics in their school. Of the 56 School Mathematics Leaders nearly two fifths (n=21) of the School Mathematics Leaders had at some stage been involved in the *Primary Mathematics Specialist* program (DEECD, 2013a, 2014).

4.1.2 Allocation of the School Mathematics Leader role.

Survey question seven asked School Mathematics Leaders: How did you become the School Mathematics Leader? Table 4.2 shows how each School Mathematics Leader became a leader of mathematics in their schools.

Table 4.2

(Q7) School Mathematics Leader Role Allocation (n=56)

Mathematics leadership	Number of School Mathematics Leaders	(%)
Applied for the role	23	(41)
Volunteered	10	(18)
Nominated by the principal	21	(38)
Other	2	(3)
Total	56	(100)

As seen in Table 4.2 of the 56 School Mathematics Leaders surveyed, 23 (41%) applied for the mathematics leadership position, 10 (18%) volunteered for the role, 21 (38%) were nominated by the principal of the school, and two (3%) School Mathematics Leaders surveyed indicated that they were previously *Primary Mathematics Specialists* and continued to be mathematics leaders following involvement in the professional development program. These data indicate that over half of the School Mathematics Leaders surveyed chose to lead mathematics in their schools through volunteering or applying for the position. While, just over a third of the School Mathematics Leaders were nominated by their principal which might indicate that they did not choose this leadership responsibility or possibly the principals saw these teachers as having leadership potential.

4.1.3 Teaching experience and leadership experience.

In Table 4.3 a crosstabulation of responses is chosen to Question 6: How many years have you been teaching in primary schools? and Question 8: How many years have you been a School Mathematics Leader?

Table 4.3

(Q6, Q8) The Cross-Tabulation Distribution of Participants' Teaching Experience and Mathematics Leadership Experience (n=56)

Years of teaching experience	Years of mathematics leadership experience					
	1-2 years	2-3 years	3-4 years	4-5 years	5 + years	Total
1–5 years	4	1	0	1	0	6
5–10 years	9	5	3	0	0	17
10–20 years	6	5	0	3	3	17
20–30 years	0	0	0	1	6	7
30 + years	1	0	0	0	8	9
Total	20 (36%)	11 (20%)	3 (5%)	5 (9%)	17 (30%)	56 (100%)

From the data in Table 4.3 it seems true to say that experience in teaching is associated with being appointed a School Mathematics Leader. As highlighted in the table, only six (11%) of the School Mathematics Leaders in their first 5 years of teaching were appointed to the role. The largest group to lead mathematics were 34 (61%) School Mathematics Leaders with between five and twenty years experience. While 16 (29%) School Mathematics Leaders had been teaching for 20 years or more. Of these 16 (29%) School Mathematics Leaders, 14 (25%), which is a quarter of the group of School Mathematics Leaders surveyed, had also been leading mathematics for more than five years (see highlighted section). Interestingly there was a similar sized group of 15 (28%) who had between five and 20 years teaching experience that had only been leading mathematics for one to two years (see highlighted section). Six School Mathematics Leaders from this group were *Primary Mathematics Specialists* (DEECD, 2013a, 2014) who were beginning leaders as part of this Victorian state government program which might account for the larger number.

4.1.4 Location of schools.

In Victoria the Department of Education has four regions across Victoria. This survey collected data from School Mathematics Leaders from each of the four regions. Figure 4.1 provides a detailed diagram of the regions.

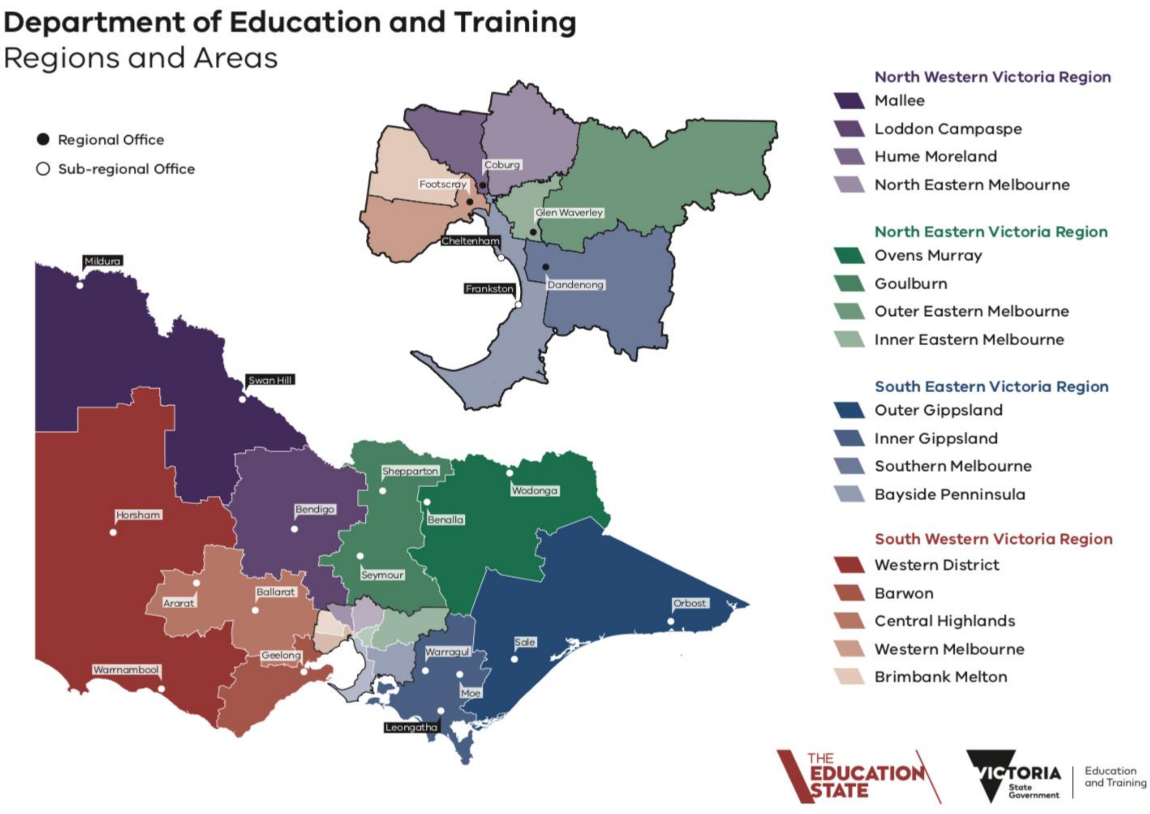

Figure 4.1. Department of Education and Training regions and areas of Victoria (DET, 2019)

Survey question two asked the School Mathematics Leaders the name of the school at which they taught. Table 4.4 shows the regional location of the particular schools in which the School Mathematics Leaders taught (n=56).

Table 4.4

(Q2) Regional location of schools in which School Mathematics Leaders taught (n=56)

DET Victoria Region	Number of School Mathematics Leaders	(%)
South Western	28	(50)
South Eastern	18	(32)
North Eastern	5	(9)
North Western	5	(9)
Total	56	(100%)

Half (n=28) of the responses to the survey were from School Mathematics Leaders in the South-Western Region of Victoria (n=28). This region covers the largest area (see Figure 4.1) of Victoria and included many schools from the Barwon region and the Western suburbs of Melbourne. The least number of responses were from schools in the North-

Eastern (n=5) and North-Western (n=5) regions, while almost a third (n=18) of the responses were from the South-Eastern region.

4.1.5 School size or school student enrolment.

Table 4.5 shows a cross-tabulation of responses to Question 3: What is your schools current student enrolment? And Question 8: How many years have you been a School Mathematics Leader? Table 4.5 shows the relationship between these two items.

Table 4.5

(Q3, Q8) The Cross-Tabulation Distribution of School Student Enrolment and Mathematics Leadership Experience (n=56)

School student enrolment	Years of mathematics leadership experience					
	1–2 years	2–3 years	3–4 years	4–5 years	5 + years	Total
Less than 100	1	1	0	0	0	2
100–200	5	3	0	0	5	13
200–300	1	1	1	2	2	7
300–500	5	3	1	1	5	15
500–800	6	0	1	1	4	12
800 + students	2	3	0	1	1	7
Total	20	11	3	5	17	56

Table 4.5 shows an interesting spread of experience with leading mathematics across schools of different sizes. In schools with less than 100 students the School Mathematics Leaders were inexperienced. In schools with between one hundred and three hundred students there was a fairly even spread of inexperienced (n=10) and experienced (n=9) School Mathematics Leaders. There was also a fairly even spread of inexperienced (n=14) and experienced (n=11) School Mathematics Leaders from schools with between three hundred and eight hundred students. Interestingly, the schools with more than eight hundred students had more inexperienced (n=5) School Mathematics Leaders than experienced (n=2) School Mathematics Leaders. In summary there were more School Mathematics Leaders with between one to three years' experience, than between four to five plus years' experience. Also, of note was a particularly small number (n=3) of leaders with three to four years' experience in any of the schools.

4.1.6 Classroom teaching responsibilities.

For survey question 13 School Mathematics Leaders were asked: Do you have classroom teaching responsibilities? Table 4.6 shows of the number of School Mathematics Leaders surveyed, including years of experience in leading mathematics, and the number of leaders who were also responsible for teaching students in classrooms.

Table 4.6

(Q13) School Mathematics Leaders' Classroom Teaching Responsibilities (n=56)

Years of mathematics leadership experience	Yes	No
1–2 years	17	3
2–3 years	7	4
3–4 years	3	0
4–5 years	3	2
5+ years	8	9
Total	38 (68%)	18 (32%)

While the role of School Mathematics Leaders is to support teachers to teach mathematics more effectively, there were many leaders who had the added responsibility of classroom teaching. Thirty-eight (68%) School Mathematics Leaders indicated that they had classroom teaching responsibilities. Seventeen (30%) of these leaders had only one- or two-years' experience leading mathematics. The time allocated to these teaching responsibilities ranged from teaching eight hours a week to a full-time teaching allocation. While 18 (32%) worked full-time in a mathematics leadership role and were not responsible for teaching a particular grade.

The following quotes provide evidence of the School Mathematics Leaders responses in relation to their classroom teaching responsibilities. This quote summarises, responses to question 13 when the School Mathematics Leaders were asked if they had classroom teaching responsibilities. The frustration of teaching full time in a classroom with no additional time release was expressed in this comment:

> The workload in being a leader in the school is enormous and I feel it is almost impossible to be an effective classroom teacher and an effective curriculum leader. [Participant 7]

Participant 7 expressed her belief, that to be more effective, dedicated time was needed for mathematics leadership with limited classroom teaching responsibilities. The next comment demonstrates this point further:

> I was a full-time maths specialist at my last school. It was such a privilege. Now they don't have a full-time person driving the change, and I think it makes all the difference. [Participant 30]

Participant 30 believed teacher learning and teacher change were far more likely to occur when time was provided to allow the School Mathematics Leader to focus solely on leading mathematics in the school.

4.1.7 Principal support.

Survey question 11 sought to gauge the School Mathematics Leaders perceived level of principal support. Table 4.7 shows a summary of responses on a scale of 1 to 10 to: Thinking about my role as a School Mathematics Leader I feel supported by the principal.

Table 4.7

(Q11) School Mathematics Leaders' Perception of Principal Support (n=56)

Response Scale	1 Not	2	3	4	5	6	7	8	9	10 Very
Frequency	0	0	1	1	3	3	6	11	12	19
Percentage	0	0	2	2	5	5	11	20	21	34

In response to this question, Table 4.7 shows that 19 (34%) School Mathematics Leaders rated their principal support as a ten (very supported), 12 (21%) as a nine, 11 (20%) as an eight, six (11%) a seven and eight (14%) a six or below. Three quarters of the respondents (n=42) who rated principal support as eight or more out of ten, possibly felt they were working well with their principal, and that their role was valued and supported. It is important to note that only five (9%) respondents rated their principal at or below the mid-point on the scale of support.

4.2 Findings from the Three Open Questions

The survey also included three open questions:

- Q21: In what ways do you support mathematics professional learning in your school?

- Q22: List at least three key challenges you have experienced as a School Mathematics Leader.

- Q23: List at least three achievements you have initiated in your role as a School Mathematics Leader.

Initial responses from the School Mathematics Leaders (n=56) for the three open questions were complied. A series of categories were generated within these responses and are presented in Table 4.8. The letters (nr) indicate the total number of coded responses for each question.

Table 4.8

(Q21, Q22, Q23) School Mathematics Leaders' Responses (n=56)

Categories /codes	(Q21) Supports (nr=145)	(Q22) Challenges (nr=133)	(Q23) Achievements (nr=111)
Professional development/learning	36	4	14
Time	0	30	0
Mathematics planning	20	0	17
Assessment and data	23	10	33
Working in classrooms	29	10	6
Teacher resistance	0	21	0
Teacher MKT	20	24	29
School Mathematics Leader confidence	0	20	2
Budgets and resources	17	14	10

The School Mathematics Leaders who responded to the survey believed they provided the most support with professional learning and development (n=36). The greatest challenge, according to the 56 School Mathematics Leaders, was time (n=30), while the survey results (n=33) showed these leaders believed their major achievement was supporting teachers with assessment and data.

4.2.1 Question 21.

Categories emerged from the data that described ways in which School Mathematics Leaders supported mathematics professional learning in their schools. These categories included: providing professional development that led to professional learning for teachers; working alongside teachers in classrooms; using assessment and data; mathematics planning; developing teachers' mathematical knowledge for teaching; and organising resources and budgets. A summary is presented in Table 4.9 in order of the most to least frequent supports for teachers' professional learning, including total number of responses (nr).

Table 4.9

(Q21) School Mathematics Leaders' Responses Related to Support Provided (nr=145)

Categories in order of frequency	Support (nr=145)	%
Professional learning	36	25
Working alongside teachers in classrooms	29	20
Assessment and data	23	16
Mathematics planning	20	14
Teacher's mathematical knowledge for teaching	20	14
Resources and budgets	17	11
Total number of responses	145	100

Results to question 21 recorded in Table 4.9 show that a quarter (nr=36) of the responses related to professional learning which indicated that many School Mathematics Leaders in the study believed they supported teachers by providing and facilitating professional development and professional learning in various ways. Just over a fifth (nr=29) of the responses related to working alongside teachers in classrooms, while nearly a sixth (nr=23) of the responses indicated that School Mathematics Leaders believed they supported teachers with the use of assessment and data. Twenty responses indicted that the School Mathematics Leaders believed they supported teachers with planning mathematics lessons. Twenty responses also related to building teachers' mathematical knowledge for teaching in various ways. Seventeen responses from the School Mathematics Leaders indicated that they believed they supported teachers by providing, organising and managing mathematics resources and budgets.

4.2.2 Question 22.

Question 22 asked the School Mathematics Leaders to identify three key challenges they had experienced in mathematics leadership. The broad categories identified were: time; teachers' mathematical knowledge for teaching; teacher resistance; School Mathematics Leader confidence; resources and budgets; working alongside teachers in classrooms; assessment and data; and mathematics professional learning. The collated number of responses are presented in Table 4.10 in order of frequency.

Table 4.10

(Q22) School Mathematics Leaders' Responses to Three Key Challenges (nr=133)

Categories in order of frequency	Challenges (nr=133)	%
Time	30	23
Teacher's mathematical knowledge for teaching	24	18
Teacher resistance	21	16
School Mathematics Leader confidence	20	15
Resources and budgets	14	10
Working alongside teachers in classrooms	10	8
Assessment and data	10	8
Professional learning	4	3
Total number of responses	133	100

Results in Table 4.10 show that nearly a quarter (nr=30) of the responses indicated that limited time to achieve the expectations of the role was a key challenge they had experienced. Nearly a fifth (nr=24) of the responses from the School Mathematics Leaders described teachers' mathematical knowledge for teaching as a key challenge, followed by teacher resistance (nr=21), School Mathematics Leader confidence (nr=20), organisation of resources and management of budgets (nr=14). The use of assessment and data (nr=10), the ability to work alongside teachers in classrooms (nr=10) and being able to provide professional learning (nr=4) were also seen as challenges by the School Mathematics Leaders.

4.2.3 Question 23.

Responses to Question 23 which asked School Mathematics Leaders to describe at least three achievements they had initiated in their schools were collated in order of frequency for each of the broad categories that were identified. The broad categories identified were, assessment and data, teachers' mathematical knowledge for teaching, mathematics planning, professional learning, resources, and budgets, working alongside teachers in classrooms and School Mathematics Leader confidence. The results are presented in Table 4.11.

Table 4.11

(Q23) School Mathematics Leaders' Responses to Three Initiated Achievements (nr=111)

Categories in order of frequency	Achievements (nr=111)	%
Assessment and data	33	30
Teacher's mathematical knowledge for teaching	29	26
Mathematics planning	17	15
Professional learning	14	13
Resources and budgets	10	9
Working alongside teachers in classrooms	6	5
School Mathematics Leader confidence	2	2
Total number of responses	111	100

Nearly a third (nr=33) of the responses to question 23 that asked School Mathematics Leaders to list at least three achievements they had initiated in their role were related to assessment and data. More than a quarter (nr=29) of the responses indicated that the School Mathematics Leaders believed that one of their greatest achievements was building mathematical knowledge for teaching. Close to a sixth (nr=17) of the responses from the School Mathematics Leaders suggested that one of their achievements was support of mathematics lesson planning, followed by providing and facilitating professional learning (nr=14), organising resources and managing budgets (nr=10), working alongside teachers in classrooms (nr=6) and the development of increased confidence in leading mathematics (nr=2).

4.2.4 School Mathematics Leaders support (Q21).

Responses for question 21 in which School Mathematics Leaders described ways they supported teacher professional learning were grouped into the six main categories as presented in Table 4.9. Following further analysis of the responses, linked sub-categories were created and ideas related to each sub-category were coded and collated. In total there were 166 ideas for question 21. Quotes that typify and illustrate the ideas included in each sub-category have also been included. Each category will be discussed in turn from the most frequent to the least frequent. A summary of the number of ideas (ni) are presented in each table as follows.

4.2.4.1 Professional learning/ professional development.

Results from further analysis of the category of professional learning are shown in Table 4.12. This table shows the largest number of ideas (n=33) in the teacher survey data that were related to professional learning.

Table 4.12

Professional Learning (ni=45)

Category	Sub-category	Illustrative quotes	Number of ideas (ni)
Professional learning/ professional development	Present professional learning/ professional development	Running whole school professional learning sessions	33
	Organise professional development for staff	Organise PD from outside experts	11
	Attend professional development and share	Attend PD myself and then disseminate to whole school	1
			Total: 45

Table 4.12 indicates that the School Mathematics Leaders believed they supported teacher's mathematics professional learning through presenting professional development (ni=33) sessions. For example, one response was, "I provide professional learning for this team as well as set the agenda. I provide termly maths professional learning for the whole staff based on what the data and anecdotal evidence shows the school needs to improve on." To a lesser extent (ni=11), ideas indicate that the School Mathematics Leaders organised professional development from outside experts and in one case attended external professional development and then reported back to teachers in their school. Overall a total of 45 ideas show that the School Mathematics Leaders who took part in the survey believed presenting professional development in their schools was an important way they had supported teachers to extend their knowledge for teaching mathematics. It might also suggest that the School Mathematics Leaders felt confident enough to conduct professional development.

4.2.4.2 Working alongside teachers in classrooms.

Results showed that one way the School Mathematics Leaders believed they supported teachers was working in classrooms. Table 4.13 shows the number of ideas from the survey reporting on the category of working alongside teachers in the classroom.

Table 4.13

Working Alongside Teachers in Classrooms (ni=32)

Category	Sub-category	Illustrative quotes	Number of ideas (ni)
Working alongside teachers in classrooms	Coach/Mentor	Weekly coaching to staff members as well as some targeting coaching if a particular need arises	25
	Observe and provide feedback	I participate in peer observations where teachers will observe me model a lesson and then I will observe them	5
	Team teaching	I team teach with Year 3/4 teachers around problem solving	2
			Total: 32

Table 4.13 shows the most frequent number of ideas (ni=25) related to supporting teachers in a coaching or mentoring capacity. The second most frequent number of ideas (ni=5) concerned mathematics lesson observations and feedback followed by team teaching with two related ideas included in the survey. Although many of the comments were sometimes brief, for example, “in class coaching” one illustrative response was, “I provide mentoring for teachers who watch me teach and I watch them teach and support their learning.” A total of 32 ideas related to working with teachers in their actual classrooms which indicates that the School Mathematics Leaders believed this to be an important part of the work.

4.2.4.3 Assessment and data.

Results showed that the School Mathematics Leaders believed they supported teachers to analyse assessment and data as can be seen in Table 4.14.

Table 4.14

Assessment and Data (ni=27)

Category	Sub-category	Illustrative quotes	Number of ideas (ni)
Assessment and data	Analyse data/ results	Analyse school data to monitor progress of students	17
	Administer /oversee whole school assessment	Oversee the implementation of external tests such as Numeracy on-line, NAPLAN, On Demand etc	7
	Provide related support for teachers	Support understanding of maths assessments including: Common Misunderstandings, Scaffolding Numeracy, Early Years Numeracy Interview, PAT, Rich assessment tasks	3
			Total: 27

The next category of assessment and data (ni=27) has been broken down into three more specific categories, supporting teachers to analyse the data (ni=17), administering a variety of assessment (ni=7) and providing support to teachers (ni=3) on how to use the data to inform teaching. Judging from these results it could be assumed that School Mathematics Leaders believed they were able to provide valuable support with assessment and data in their schools.

4.2.4.4 Mathematical knowledge for teaching.

School Mathematics Leaders also believed they provided support with building teacher content knowledge and knowledge of effective practice for teaching mathematics as shown in Table 4.15.

Table 4.15

Mathematical Knowledge for Teaching (ni=24)

Category	Sub-category	Illustrative quotes	Number of ideas (ni)
Mathematical knowledge for teaching	Provide professional reading / lesson ideas	We read Booker and have been building our understanding around best practice and developing consistent understanding around how concepts are taught.	11
	Support individual teachers	Suggestions for individual students and areas of focus at teachers request.	7
	Build teacher expertise/knowledge (generally)	Support with engagement and curriculum when necessary	6
			Total: 24

Table 4.15 shows the category of mathematical knowledge for teaching (ni=24) was separated into the more specific sub-categories of providing professional reading (ni=11), supporting individual teachers (ni=7) and building teacher expertise/knowledge (generally) (ni=6). These results suggest that the School Mathematics Leaders believed providing professional reading was a valuable way of supporting teacher learning, which is also reflected in this comment, “we provide readings that address the requirements of effective Mathematics teaching.” Although professional reading could also be coded as professional learning, it was decided to include it in this category as this was one way to develop mathematical knowledge for teaching.

4.2.4.5 Planning.

The School Mathematics Leaders believed that supporting teachers with mathematics planning was important. Table 4.16 shows a total of 21 related ideas.

Table 4.16

Planning (ni=21)

Category	Sub-category	Illustrative quotes	Number of ideas (ni)
Planning	Support teacher planning	Provide support for other teachers for their mathematics planning	15
	Attend planning sessions	I plan with each team on a fortnightly basis and assist in year term and unit planners	6
			Total: 21

Table 4.16 shows that specified support (ni=15) was provided were general. While a small number (ni=6) of ideas indicates that the School Mathematics Leaders attended at least some of the planning sessions. Although it was difficult to interpret from some of the brief comments such as “help with planning,” based on these results, it was fair to say that many School Mathematics Leaders did not plan with teachers in their schools.

4.2.4.6 Resources and budgets.

Table 4.17 provides evidence of the number of ideas related to resources and budgets.

Table 4.17

Resources and Budgets (ni=17)

Category	Sub-category	Illustrative quotes	Number of ideas (ni)
Resources and budgets	Organise/ provide /maintain resources	Maintain and monitor all resources from prep to 6	9
	Purchase /audit	Manage the mathematics budget and order resources	8
			Total: 17

Respondents believed they supported teachers in their schools by organising and maintaining mathematics resources (ni=9) as well as purchasing equipment (ni=8).

Although this is seen as a managerial element of the mathematics leadership role, it is something tangible that School Mathematics Leaders were able to do to support teachers and a necessary part of the work.

4.2.5 Key challenges experienced as a School Mathematics Leader (Q22).

Responses from this item were categorised into slightly different main categories and sub-categories that related to responses to question 22, indicating three key challenges experienced by the School Mathematics Leaders. The number of ideas (ni) for each sub-category are recorded. In total there were 151 ideas for question 22. Illustrative quotes have been included again to reveal the context. Each category will be discussed in turn from the most frequent to the least frequent beginning with table 4.18.

4.2.5.1 Time.

The issue that School Mathematics Leaders believed created the most challenge as they led mathematics in their schools was time. Table 4.18 shows evidence of the number of ideas related to time (ni=34).

Table 4.18

Time (ni=34)

Category	Sub-category	Illustrative quotes	Number of ideas (ni)
Time	Time to work with teachers/coach/ observe/ plan	Running whole school professional learning sessions	19
	Time (unspecified)	Organise PD from outside experts	9
	Time release for organisation /managerial aspects	Attend PD myself and then disseminate to whole school	6
			Total: 34

When classified into three specific sub-categories, Table 4.18 shows just over half (ni=19) of the 34 ideas suggested that time for School Mathematics Leaders to visit classrooms, and provide more support to teachers through coaching, modelling or observing and giving feedback was very limited. There were nine ideas that were unspecified and very brief such “time constraints” and “time allocation.” A small number (ni=6) of School Mathematics Leaders believed that time release to complete all the things they wanted or needed to do was difficult to find. For example, one idea was, “time to give more support to teams and individual teachers.” Another School Mathematics Leader indicated being time poor in this comment, “Lack of time. I do a lot of the work necessary outside of school hours” which is mentioned in the literature as a common challenge experienced by others.

4.2.5.2 Mathematical knowledge for teaching.

Respondents believed a further challenge was developing teacher’s capacity to teach mathematics. Ideas related to mathematical knowledge for teaching are shown in Table 4.19.

Table 4.19

Mathematical Knowledge for Teaching (ni=30)

Category	Sub-category	Illustrative quotes	Number of ideas (ni)
Mathematical knowledge for teaching	Teacher expertise/ knowledge (generally)	Moving teachers away from worksheets and prescribed activities that don’t allow for differentiation	22
	Support individual teachers	Providing new staff … or teachers returning from family leave with PD [to] upskill them to where our other teachers are	8
			Total: 30

Table 4.19 shows when analysed further, of the 30 ideas related to developing teacher’s knowledge for teaching, three quarters (ni=22) of these ideas were related to the sub-category of teacher expertise and teacher knowledge generally. This was evidenced in this comment, “We have a very young, inexperienced staff who have endless enthusiasm. However, we have had to spend a long time building up pedagogical content knowledge along with effective teaching structures for maths.” Just over a quarter (ni=8) of the 30 ideas referred to providing support for individual teachers. “Support for certain teachers in the implementation of new programs” and “some staff members have a real need for support” were two ideas expressed as challenges by these School Mathematics Leaders.

4.2.5.3 Resistance.

The School Mathematics Leaders believed that teacher resistance (ni=20) was a concern and provided a challenge for them as leaders as shown in Table 4.20.

Table 4.20

Resistance (ni=20)

Category	Sub-category	Illustrative quotes	Number of ideas (ni)
Resistance	Resistant/ reluctant teachers/ closed doors	Some staff have had particular viewpoints which haven't matched the direction of the school and the best practice approach	18
	Attitude towards mathematics	Negativity towards mathematics	2
			Total: 20

Table 4.20 shows 18 specific ideas that indicated resistant or reluctant teachers and closed doors. Indicative quotes included, "resistance to change by some individual staff," "closed doors and barriers," "unmotivated and untrained staff," "teachers not willing to change," and "stubbornness from other teachers to implement new strategies or whole school assessment." There was also a suggestion of negativity towards mathematics (ni=2) by teachers in two schools.

4.2.5.4 School Mathematics Leader confidence.

The results in Table 4.21 show that School Mathematics Leaders' (n=28) lacked confidence in their ability to lead mathematics effectively.

Table 4.21

School Mathematics Leader Confidence (ni=28)

Category	Sub-category	Illustrative quotes	Number of ideas (ni)
School Mathematics Leader Confidence	Lack of confidence/ support/ credibility/ inexperience	Lack of training and expertise for myself	22
	Clarity of the role	Job description not clear	6
			Total: 28

Table 4.21 shows that ideas were categorised into two sub-themes, lack of confidence or inexperience (ni=22) and role clarity (ni=6). One School Mathematics Leader highlighted her concerns and lack of confidence in this comment, “not enough time to discuss direction with my principal [or] strategies to support me as a coach/mentor.” While another was worried about, “being new to leading a curriculum area and knowing what to do as a leader.” Not only is being new to leading mathematics a challenge, but as one School Mathematics Leader stated, “coming into the school and establishing myself as a leader and building relationships with teachers was challenging.”

4.2.5.5 Resources and budgets.

The results in Table 4.22 reveal that the School Mathematics Leaders also believed providing adequate resources (ni=8) for teachers was a challenge.

Table 4.22

Resources and Budgets (ni=14)

Category	Sub-category	Illustrative quotes	Number of ideas (ni)
Resources and budgets	Organise / gather resources	Ensuring there are enough resources to support the program	8
	Lack of budget	Money is limited or non-existent	6
			Total: 14

Table 4.22 shows resources and budgets were a concern. Many School Mathematics Leaders commented on the availability of money in the budget (ni=6) to provide necessary equipment for classrooms, for example, “money – budget for resources and human resources in relation to release time to work collaboratively with teams.” This comment reflects the School Mathematics Leaders belief that money needs to be available to allow teachers to be released to meet together for collaborative meetings, but also possibly for the School Mathematics Leader to attend the meetings.

4.2.5.6 Assessment and data.

Assessment practices were perceived as another challenge by the School Mathematics Leaders who responded to this survey as is evidenced in Table 4.23.

Table 4.23

Assessment and Data (ni=11)

Category	Sub-category	Illustrative quotes	Number of ideas (ni)
Assessment and data	Analyse data/ results	Data collection and analysis	3
	Administer / develop whole school assessment	We had to develop an assessment schedule	5
	Use data	Effective assessment practices that inform reporting so that teachers trust the data from the previous year	3
			Total: 11

Results in Table 4.23 show that the School Mathematics Leaders believed data collection and analysis (ni=3) was a challenge, as well as the administration of assessment (ni=5). Supporting teachers to analyse the data (ni=3), and to use it to inform teaching was also described as a challenge worth noting.

4.2.5.7 Working alongside teachers in classrooms.

Results in Table 4.24 show that working in classrooms in some capacity was a further challenge (ni=10) experienced by the School Mathematics Leaders.

Table 4.24

Working Alongside Teachers in Classrooms (ni=10)

Category	Sub-category	Illustrative quotes	Number of ideas (ni)
Working in classrooms	Coach/ Mentor in classrooms	Getting into all grades to complete coaching	10
			Total: 10

The responses shown in Table 4.24 related to the specific idea of, "getting to all grades to complete coaching," suggested that it was difficult to work alongside teachers for several reasons. Some of these difficulties were connected to having available time to work in classrooms, being free of other responsibilities, or perhaps teacher resistance and closed doors.

4.2.5.8 Professional learning/ professional development.

Results from the School Mathematics Leaders as presented in Table 4.25 suggested that organising and providing professional learning was a challenge.

Table 4.25

Professional Learning (ni=4)

Category	Sub-category	Illustrative quotes	Number of ideas (ni)
Professional learning	Organise professional learning/ professional development for staff	Professional development what and when based on teacher and school needs (lack of input from teachers)	4
			Total: 4

Table 4.25 shows a small number of ideas (ni=4) related to professional learning. One particular School Mathematics Leader believed that “effectively implementing strategies to support teachers” was a leadership challenge. While another commented that “regional PD opportunities” were a challenge, which might imply that regional professional development opportunities were limited or difficult to attend.

4.2.6 School Mathematics Leader initiated achievements (Q23).

School Mathematics Leaders responses to question 23 described major achievements they believed they had initiated in their schools and are presented in Table 4.11. Responses were grouped into seven main categories then coded into a linked sub-category. Sub-categories were created that specifically related to the responses to question 23. The number of coded ideas (ni) to each sub-category are recorded. In total there were 133 ideas for question 23. Illustrative quotes have also been included to indicate the context. Each category will be discussed in turn from the most frequent to the least frequent, beginning with Table 4.26.

4.2.6.1 Assessment and data.

Table 4.26 shows that the School Mathematics Leaders believed that a major achievement in their mathematics leadership role related to supporting teachers with the use of assessment and data.

Table 4.26

Assessment and Data (ni=42)

Category	Sub-category	Illustrative quotes	Number of ideas (ni)
Assessment and data	Develop/ use/ analyse assessment	Whole school moderation of common assessment tasks	30
	Provide related support for teachers	Developing staff capacity to use and understand data to inform teaching and learning	8
	Improved student results e.g., NAPLAN	A steady upward trend in NAPLAN and other data sets in the past three years	4
			Total: 42

Ideas (ni=42) in Table 4.26 were categorised into the three sub-categories. Nearly three quarters (ni=30) of the ideas expressed in this category indicated that the School Mathematics Leaders believed they had developed, used and analysed assessment and data, for example, the implementation of a range of moderation tasks, "school wide data collection," and "whole school assessment schedules." The results show that the School Mathematics Leaders provided related support for teachers (ni=8), developed staff capacity to use and understand data to inform teaching and learning, and believed they were partly responsible for improved student results (ni=4).

4.2.6.2 Mathematical knowledge for teaching.

Results in Table 2.7 show that building mathematical knowledge for teaching was considered a major achievement initiated by School Mathematics Leaders.

Table 4.27

Mathematical Knowledge for Teaching (ni=33)

Category	Sub-category	Illustrative quotes	Number of ideas (ni)
Mathematical knowledge for teaching	Build teacher expertise/knowledge	Developing challenging tasks as part of the curriculum	24
	Assist with readings/ lesson ideas	Development of documents for an effective maths classroom	8
	Support individual teachers	When teachers are unsure how to teach a concept asking for advice	2
			Total: 34

Table 4.27 shows that 34 ideas related to mathematical knowledge for teaching were recorded. Ideas that related to building teacher expertise and knowledge (ni=24) provided evidence that the School Mathematics Leaders believed they were partly responsible for developing teacher's mathematical knowledge for teaching, by for example, "introducing a new planning format across the school that includes the following elements Launch, Discover, Summary, enabling and extending prompts." Also, by assisting with professional readings and lesson ideas (ni=8) and supporting individual teachers (ni=2) with mathematical content knowledge.

4.2.6.3 Planning.

Table 4.28 shows that School Mathematics Leaders believed a major achievement in their practice was working with teachers as they planned their mathematics lessons.

Table 4.28

Planning (ni=23)

Category	Sub-category	Illustrative quotes	Number of ideas (ni)
Planning	Whole school planning models/ practices	Working towards consistency with maths planning	16
	Effective planning	Planning maths to reflect the data and teachers seeing the value in this	7
			Total: 23

There were 23 ideas recorded in Table 4.28 that related to planning. Two sub-categories illustrated mathematics planning, which included whole school planning models or practices (ni=16) and can be illustrated in this comment, "I have implemented a year term and unit planner model." The second sub-category was effective planning (ni=7). An example of an idea that indicated this was, "the Junior PLT using the Maths Online Interviews to plan units of work."

4.2.6.4 Professional learning/ professional development.

School Mathematics Leaders also believed they were able to provide professional development opportunities that supported teacher learning in their schools as shown in Table 4.29.

Table 4.29

Professional Learning (ni=16)

Category	Sub-category	Illustrative quotes	Number of ideas (ni)
Professional learning	Present professional development	Providing PD to staff promoting the use of Challenging Tasks	7
	Attend or organise external professional development	Attending and encouraging others to attend PD	6
	Professional discussion	We are working towards the whole staff unpacking the Vic Curriculum and creating 'I can' statements to break down what each point actually means.	2
			Total: 15

The total number of related ideas (ni=15) in Table 4.29 were separated into three sub-categories, presenting professional development (ni=7), attending or organising external professional development (ni=6) and professional discussion (ni=2). One School Mathematics Leader pointed out that they presented professional development in this comment, "held whole school PD related to open ended tasks, rich assessment tasks." While another School Mathematics Leader shared this idea, "gained a better understanding of teaching strategies through PD" which would indicate the second sub-category of attending professional development which was also noted as an achievement.

4.2.6.5 Resources and budgets.

The results in Table 4.30 show the number of ideas related to providing resources (ni=8) for teachers.

Table 4.30

Resources and Budgets (ni=11)

Category	Sub-category	Illustrative quotes	Number of ideas (ni)
Resources and budgets	Organise/gather /maintain resources	Provided resources to assist staff	11
			Total: 11

Results in Table 4.30 show eleven ideas indicated that the School Mathematics Leaders believed one of their achievements was to organise and provide resources to assist staff.

4.2.6.6 Working alongside teachers in classrooms.

Ideas related to working in classrooms as shown in Table 4.31 were separated into two sub-categories.

Table 4.31

Working Alongside Teachers in Classrooms (ni=6)

Category	Sub-category	Illustrative quotes	Number of ideas (ni)
Working alongside teachers in classrooms	Coaching/Mentoring	I believe from my coaching; staff are more focused on creating problem solving activities	3
	Modelling/observations in classrooms	Asking someone to model or observe teaching	3
			Total: 6

Table 4.31 shows that School Mathematics Leaders felt being able to support teachers in the classroom through coaching or mentoring (ni=3) was an achievement. Having the opportunity to model the teaching of a mathematics lesson for teachers to observe was also seen as an achievement by School Mathematics Leaders (ni=3).

4.2.6.7 School Mathematics Leader confidence.

The number of ideas (ni=2) shown in table 4.32 might suggest that confidence was considered an achievement by School Mathematics Leaders.

Table 4.32

School Mathematics Leader Confidence (ni=2)

Category	Sub-category	Illustrative quotes	Number of ideas (ni)
School Mathematics Leader Confidence	Self-confidence/efficacy	My own leadership and pedagogical content knowledge have grown significantly, and I have been able to run PD	2
			Total: 2

Although the results in Table 4.32 were small (n=2), seeing confidence as an achievement was important as it had previously been described as a challenge experienced by School Mathematics Leaders. In this response one particular School Mathematics Leader believed one of her achievements was, “My own leadership and pedagogical content knowledge have grown significantly, and I have been able to run PD” which would suggest increased confidence. While another School Mathematics Leader indicated improved confidence in this comment, “staff come to me. Staff feel supported.” Although there were only two responses, it was interesting to report personal confidence in a positive light.

4.3 Themes That Emerged from the Three Open Questions

School Mathematics Leaders’ responses and ideas from the three open questions (Q21, Q22, Q23) were coded and collated. The responses and ideas provided background information related to the ways in which the School Mathematics Leaders believed they supported teachers. In Table 4.33 a summary of these responses and ideas is provided.

Table 4.33

(Q21) Number of School Mathematics Leaders' Responses and Ideas Related to Support

Categories in order of frequency	Responses (nr=145)	Ideas (ni=166)
Professional development/learning	36	45
Working alongside teachers in classrooms	29	32
Assessment and data	23	27
Teachers' Mathematical knowledge for teaching	20	24
Mathematics Planning	20	21
Resources and budgets	17	17
Total	145	166

The three major themes that emerged from question 21 that indicated ways in which the School Mathematics Leaders believed they supported primary teachers' professional learning were:

1. Professional development/professional learning
2. Working alongside teachers in classrooms
3. Assessment and data

The first two themes will be discussed in the next section.

4.3.1 Professional development /professional learning.

Responses to the survey provided evidence that professional development was a large focus of the work of the School Mathematics Leaders. With a total of 36 responses and 45 ideas recorded for question 21 this suggests that delivering professional development was a crucial way the School Mathematics Leaders believed they supported teachers in their schools. Comments such as, "I organise professional development for the staff from outside experts and deliver professional development at least once per term" [Participant 36], or "I provide professional development on maths initiatives and new curriculum" [Participant 53] were indicative of the ways in which School Mathematics Leaders believed they supported teachers' professional learning.

4.3.2 Working alongside teachers in classrooms.

A further theme that became apparent from the survey responses was the practice of School Mathematics Leaders working alongside teachers in classrooms and supporting teachers through modelling, mentoring, coaching and team teaching. As this was the second highest total number of responses (nr=29) and ideas (ni=32) recorded by School Mathematics Leaders surveyed in question 21, it could be inferred that working alongside teachers in classrooms as part of their mathematics leadership was an important way these leaders supported teachers to learn. One School Mathematics Leader explained as part of her practice:

> Recently I have been able to mentor some grad [graduate] teachers by peer teaching maths in their classrooms. [Participant 43]

This support could be viewed as a potential opportunity for the teachers to learn in the classroom through a more experienced colleague, in an attempt to improve the quality of mathematics teaching. It must also be remembered that 38 (68%) School Mathematics Leaders had classroom teaching responsibilities in addition to School Mathematics Leadership.

Table 4.34

(Q22) Number of School Mathematics Leaders' Responses and Ideas Related to Challenges

Categories in order of frequency	Responses (nr=133)	Ideas (ni=151)
Time	30	34
Teachers' mathematical knowledge for teaching	24	30
Teacher resistance	21	20
School Mathematics Leader confidence	20	28
Resources and budgets	14	14
Assessment and data	10	11
Working alongside teachers in classrooms	10	10
Professional development/learning	4	4
Total	133	151

Responses and ideas provided background information related to the challenges that School Mathematics Leaders reported they had experienced in their mathematics leadership role. The three major themes that emerged were:

1. Time
2. Teachers' mathematical knowledge for teaching
3. Teacher resistance

The first two themes will be discussed in the sections that follow.

4.3.3 Time.

Time was a challenge and a constraint in the implementation of mathematics leadership identified by the School Mathematics Leaders with the largest number of responses (nr=30) and ideas (ni=34). Survey responses showed that the School Mathematics Leaders were expected to complete many tasks in their week, such as classroom teaching, coaching, providing feedback, supporting planning, providing professional development, managing resources, supporting data analysis and collection, and developing whole school programs. Time is needed to meet and plan with teams, and to work with students and teachers. As one School Mathematics Leader reported in her survey response:

> Time to get it all done. Time to give more support to teams and individual teachers. [Participant 18]

Frustration was obvious through this survey response:

> Time! (1st challenge). I find it very difficult to be as an effective leader as I would like to be. Extremely frustrating ... we don't have enough time to meet and do this during our lunchtime … Even if I was to work more i.e., full time, I would not be able to have extra time in classrooms to assist with coaching roles, look for new initiatives and implement programs. [Participant 50]

Limited time allocation for the role was also an obvious frustration in this response:

> One hour a week time release to plan Mathematics for whole school PD [professional development], data analysis, audit and manage maths resources, prepare for team meetings and provide feedback to teachers being coached. [Participant 6]

Although the School Mathematics Leaders indicated that they were hindered by time constraints, according to their responses they managed to achieve a great deal.

4.3.4 Mathematical knowledge for teaching.

As the second largest number (nr=24) of responses and ideas (ni=30) from School Mathematics Leaders in question 22, the extent of teachers' mathematical knowledge for teaching was believed to be a challenge for leaders. One School Mathematics Leader explained:

> We have had to spend a long time building up pedagogical content knowledge along with effective teaching structure and strategies for maths. [Participant 19]

From this statement it could be inferred that this particular School Mathematics Leader believed that teachers' mathematical content and pedagogical content knowledge at her school was not strong. Although judging from the number of responses (n=20) and ideas (n=24) in question 21 from the School Mathematics Leaders in relation to support provided, many believed they spent time supporting teachers to develop mathematical knowledge for teaching through coaching, modelling, mentoring, providing feedback, professional development and providing professional reading.

Table 4.35

(Q23) Number of School Mathematics Leaders' Responses and Ideas Related to Achievements

Categories in order of frequency	Responses (nr=111)	Ideas (ni=133)
Assessment and data	33	42
Teachers' mathematical knowledge for teaching	29	34
Mathematics planning	17	23
Professional learning	14	15
Resources and budgets	10	11
Working alongside teachers in classrooms	6	6
School Mathematics Leader confidence	2	2
Total	111	133

School Mathematics Leaders reported their achievements when working in their mathematics leadership role. The three major themes that emerged (see Table 4.35) were:

1. Assessment and data
2. Teachers' mathematical knowledge for teaching
3. Mathematics planning

The first two themes will be discussed.

4.3.5 Assessment and data.

The data summarised in Table 4.35 showed that School Mathematics Leaders believed an important part of their mathematics leadership role involved administering various assessment and analysing various data sets. The large number of responses (nr=33) and ideas (ni=42) related to assessment and data could be an indication of the emphasis and importance that schools place on assessment and data analysis. The number of responses could also be an indication of a trend towards using data to inform mathematics planning as this comment suggests,

> I analyse data and organise data to use at PLT [professional learning team] meetings to assist with planning. [Participant 31]

4.3.6 Mathematical knowledge for teaching.

While the extent of teachers' mathematical knowledge for teaching was considered to be a challenge by School Mathematics Leaders in question 22, the responses (nr=29) and ideas (ni=34) to question 23 indicated that the mathematics leaders believed they had initiated opportunities for teachers to build mathematical knowledge for teaching. This was evident in comments such as,

> On-site professional learning is held twice a week, ... focused on building teacher capacity to use data to design for deep learning. Teams of teachers plan and teach collaboratively to support and challenge each other's practice. Our graduate teachers are given a one-hour block each term with the Numeracy leader to debrief, goal-set and clarify. All teams have ongoing support during planning and weekly data analysis. [Participant 19]

One School Mathematics Leader explained that she,

> built teacher capacity by providing support in planning, running whole-school professional learning sessions, in class coaching and sourcing external professional learning opportunities. [Participant 42]

These examples illustrate ways in which several of the School Mathematics Leaders believed they contributed to building teachers' mathematical content knowledge and pedagogical content knowledge in their schools.

4.4 Conclusion

Data presented in Chapter 4 reported on School Mathematics Leaders' responses to a survey and provided a perspective of the current nature of mathematics leadership in Victorian primary schools. The School Mathematics Leaders surveyed reported on the number of years of teaching and leadership experience, how they were allocated to their role, the location and size of their school, classroom teaching responsibilities in addition to their role, as well as their perceived view of principal support.

School Mathematics Leaders surveyed described successes they were responsible for and achievements they had initiated. The School Mathematics Leaders believed they had supported teachers through professional development, working in classrooms and supporting the implementation of various forms of assessment and analysis of data. Based on the School Mathematics Leaders views, it was also evident that leading mathematics continued to have some challenges. Survey responses suggested the work of School Mathematics Leaders was often compromised by lack of time to lead mathematics, confidence in their own ability and clarity of role expectations, teacher mathematical knowledge for teaching, teacher resistance and the extent of classroom teaching responsibilities in addition to the leadership role. Although the majority of School Mathematics Leaders believed they had the support of their principal, it would appear that many principals did not always prioritise programs and apply sufficient funding to enable the School Mathematics Leaders to achieve maximum effectiveness. As a result, many School Mathematics Leaders experienced frustration, issues with confidence, and a degree of uncertainty.

In summary, demographic data were described and summarised in this chapter. A detailed analysis of the three open questions was completed and categories and themes that emerged were reported. The findings from this chapter also contributed to the selection of the four case study participants. The case studies will be reported in the next chapter.

Chapter 5: Findings: Phase 2—Case study

The findings from Phase 2 of the study are presented in the following four case studies: Susan, Jane, Amy and Robyn (all pseudonyms). Demographics related to the nature of each School Mathematics Leaders' leadership responsibilities are described, along with illustrations of ways in which they supported teachers to learn. Some of the challenges and successes experienced by the School Mathematics Leaders in their schools are described. In addition, the findings illustrate how each School Mathematics Leader attempted to build a community of practice with teachers in their school.

5.1 Case Study 1: Susan

Susan taught in a modern, well-resourced government school with an enrolment of just over 1000 students. The school was located in an outer suburb south-west of Melbourne in Victoria. Susan had moved from her previous school to take up a position as a Leading Teacher which involved some mathematics coaching. When Susan began teaching at this particular school, although she had completed her Master in School Leadership, specialising in Numeracy at university, Susan had virtually no previous experience in leadership. Initially in her new school, Susan was responsible for leading mathematics across three Year levels and taught part-time with five hours in a classroom. In 2016 Susan's School Mathematics Leadership role was extended to leading mathematics across the whole school, with no classroom teaching responsibilities. Susan became a full-time mathematics coach, and at the time of the study, had been a School Mathematics Leader for three years. At the initial meeting, it was obvious that Susan had a strong mathematical content (MCK) and pedagogical content knowledge (PCK) as she talked about aspects of her practice. Susan appeared to be highly organised, confident and enthusiastic about being part of the study.

Susan's data revealed how, in her role as a School Mathematics Leader, she supported teachers' professional learning. This case study begins with evidence of how Susan supported teachers when observed facilitating two Year level planning meetings. Next, some of the ways that Susan believed she supported teachers while working in classrooms are described. Some of the challenges that Susan reported in her role are outlined together with evidence of how she attempted to build a successful community of learners as she facilitated planning and professional learning team meetings.

5.1.1 Supporting teachers to learn through planning: Susan.

At Susan's school, teachers were given time to plan together. In fact, Susan stated in her first interview that teams had two-hours of planning time each week, an hour for literacy and an hour for mathematics. As the School Mathematics Leader, Susan was present during the hour of mathematics planning. Susan regarded it as part of her role to support the teachers during planning and spoke about being "really fortunate to have the time that I get, so I get full time out of the classroom to work with teachers." Susan suggested that she had a "really good working relationships with these people," and as a School Mathematics Leader she was not getting any "change resistance." However, following observation of the Year 2 and Year 6 teachers during their team planning meetings and also a Year 5/6 Professional Learning Team (PLT) meeting and video recorded evidence, this claim could be questioned. The events observed will be described in the following sections.

5.1.1.1 Year 6 planning meeting.

The first observation was a Year 6 planning meeting. The meeting began with discussion between Susan and the Year 6 team leader for the first minute, with no comment from the five other teachers in attendance. Teachers were asked by Susan to describe the results of an assessment they had brought to their meeting, and comment on the most common responses by students and any areas of concern. All teachers commented briefly on how their students had performed with the assessment. These evaluations had already been added to a template displayed on the large television screen and provided an overall snapshot of the students understanding of the topic.

While discussion continued based on the assessment data and the suitability of possible follow-up lessons to add to the weekly planning document, I noticed periods of silence. For almost a quarter of the meeting (11minutes and 56 seconds) recorded evidence showed there was no comment or discussion from the five other teachers in attendance. There were sustained periods of silence from this team, when the only contribution from one teacher was a nod of the head or a "Yes." The discussion was between Susan and the team leader without any interactions from the other teachers. Susan and the team leader continually expressed their ideas and opinions throughout the discussion with a total of 150 and 178 comments out of a total of 473 comments uttered respectively during the 52-minute meeting. This is a total of 328 comments or almost three quarters of the comments made during this planning meeting time.

The discussion that occurred between Susan and the team leader included ideas of possible lessons, as well as their views and suggestions of how to adapt aspects of these lessons to cater for student needs. When the team leader asked for a suggestion or clarification of a point related to the planning, Susan would respond almost immediately, leaving the other teachers with the option to add to the discussion or alternatively not to contribute. I also observed a similar pattern when Susan asked a question of the team and the team leader answered. Video evidence showed there were no verbal responses on seven occasions when Susan asked teachers for their opinions or directed questions to the team members. I noticed five questions were answered by the team leader, on behalf of her team, before anyone else could respond. One question was answered with a nod of the head from a teacher and there was no response to the other question. The following examples illustrate the nature of these exchanges [V#1, 26:06 - 26:08]:

> **Susan:** Do you think we need to do two whole lessons on that?
>
> **Team leader:** I don't think so. We need to change it. Whatever we do, we need to change it.

A further example that clearly illustrates the continuous interactions between Susan and the team leader occurred later in the session as teachers continued to plan mathematics lessons on fractions and debated how to begin the lesson. Susan asked the teachers in the team two questions which were immediately answered by the team leader [V#1, 41:56 - 43:05]:

> **Susan:** So, what would we want the students doing as their student activity after? I mean that could take a while though. I mean the whole discussion about firstly getting them to order it and then having the discussion about where they would go on a number line. Do you want them to make their own number line afterwards?
>
> **Team Leader:** Or should we even do this, and then get them to put it on a number line and use that as like sort of the main activity almost, and then if they need, because they won't take too long, and I like what you've been doing in the past where you've said give them a problem-solving task and they've just really had ten minutes to do it and then they discuss, and if they need to, they have a little bit more time. I found the kids really like that, where they know it's just ten minutes. They really concentrate and they do it and there's lots of discussion. So, we could say the main task is students, and maybe we don't give them anything. We just say go and

create a number line, no tools, no zero, no one, nothing on there and just see what they do. Do we want to prompt them or see if anyone discusses the actual fraction?

Following this question from the team leader attempting to seek suggestions from the other teachers in the team, I also observed Susan casually seek opinions or ideas from teachers in the team. It appeared as though she wasn't expecting a response [V#1, 43:06]:

Susan: What do you think?

There was no response to this question from any teacher in the team. Following a period of silence, [V#1, 43:06 - 43:26] as the team leader typed into the planning document, she asked a follow-up question again seeking feedback from her team:

Team leader: What do we reckon? Do we want to say to them, actually put a fraction number next to them as they put it on the line, or do we want to say put it on and see what happens and then have the discussion and then say go back and put the fractions on?

Without any hesitation Susan responded immediately with [V#1, 43:48]:

Susan: We could always sort them when they come to the floor so who used words, who used fractions and why? Get them to justify. [Then say] Do you want to go back and change your mind?

These examples highlight some of the discussion that occurred during planning with this team. Video evidence clearly demonstrated that Susan and the team leader were the main contributors to the planning. I observed several teachers seek clarification on a few points during the session, but they did not dispute any of the decisions made and appeared to agree with the lessons that were decided on. Two particular teachers stood out because of their limited contribution to the planning meeting, with 27 responses from one teacher and four from the other for the entire 52-minute meeting. Susan pointed out during a follow up interview that there were quite a few new teachers in the teams I observed and the teacher who spoke on four occasions was in her first year of teaching and was 'very shy.' It could be conjectured that teachers felt they did not need to contribute as they were happy with what was being planned, or perhaps the teachers did not have the depth of mathematical content knowledge (Ball et al., 2008), and the necessary pedagogical content knowledge (Shulman, 1986) to draw upon. Video evidence showed that Susan had strong curriculum knowledge and pedagogical content knowledge. As the Year 6 team leader asked questions Susan provided suggestions and explanations of what might work, including anticipated student responses. This discussion possibly meant that teachers felt they did not need to contribute. It could also be the case that teachers lacked confidence and were worried "about admitting they … [did not] know or understand for fear of colleagues' … reactions" (Bransford et al., 2000, p. 195).

Susan commented that her role during team planning involved, "sometimes … just one or two comments, but [in] other planning sessions I feel that I really am using the whole time to build the capacity of teachers on a needs basis." Susan explained that she was building the expertise of the teachers in many ways through structures and processes she had put in place. One example I observed was the use of assessment data for planning, where teachers were given the opportunity to analyse and discuss student work samples. However, in that instance the discussion was brief. Susan had also created what she termed a set of "essential understandings", or the priority areas of the mathematics curriculum that needed to be taught, which were intended to support planning.

During the follow-up interview, Susan spoke of her concerns about the extent of participation in planning and explained that she felt "some teams will be a little too reliant and will say, what do you think or what can we do?" and she mentioned that "they're not willing to go out on a limb. So, it's finding that balance" when working with teams. Susan explained in interview [I#1, November 23, 2016] her strategy during planning meetings:

> Sometimes I do sit back, I don't want to plan the lesson for them, so that's when … I'm doing something [else] and it's usually strategic and [I'm] saying, well, let someone else come up with something.

Although Susan suggested she had concerns about teachers being over-reliant on her and deliberately holding back, video evidence showed otherwise. However, it was interesting to note that towards the end of the planning session, as teachers were about to leave, Susan asked two teachers in the Year 6 team if they could come up with another task in their own time, to add to the planning, as it was not yet complete.

Interestingly, although the evidence showed that Susan occasionally encouraged teachers to contribute to the planning decisions, she did not "press" teachers any further for their ideas (Jackson & Cobb, 2103). "By spending time getting people's ideas and buy-in, a leader builds trust, respect, and commitment" (Goleman, 2000, p. 10) contributing to more effective leadership. The video evidence showed consistent discussion between Susan and the team leader in this meeting, but limited encouragement for teachers to contribute ideas, reducing the chance of developing trust, respect and commitment of the teachers. Based on this planning meeting, it could be conjectured that Susan was still developing this skill as teachers were not freely involved in discussion or pressed to contribute lesson ideas or share their experiences related to the teaching and learning of mathematics.

Susan's practice of meeting with team leaders before planning might also have contributed to teachers' hesitation to contribute to the planning meeting. In interview [I#1, November 23, 2016] Susan explained, "we pretty much plan what we're going to do in that session … I'll say, these are the things that I think we need to do, and they'll send out an agenda, so it's almost working on building their [team leaders] capacity as well." This is an indication of an authoritative leadership style as described by Goleman (2000) where the leader has a very strong vision and clear direction in mind. Susan shared, "at some stages I was the one running it, [the meeting] because in my mind I knew what had to happen," which indicated she believed that she knew best. I infer that the apparent lack of participation by teachers in this team may be a consequence of limited encouragement to contribute and seeing their ideas as not being valued in this situation.

Susan described her focus as building the expertise of teachers. Observations showed that Susan supported teachers in the planning process with suggestions and through the sharing of mathematical content knowledge. According to Bransford et al., (2000) the most successful teacher professional development activities extend over time while encouraging the development of learning communities. Such teacher professional development activities include involvement in experiences around the discussion of shared texts and student data related to student learning, followed by engagement in shared decision making. During this Year 6 meeting, I observed discourse around data, but interestingly there were no other resources, shared texts or teacher reference books used that might have provided support with ideas or approaches to teaching the mathematics (Bransford et al., 2000), and discussion between team members was limited, as the video evidence proved.

5.1.1.2 Year 2 planning meeting.

The second planning meeting I observed involved Susan and a Year 2 team. There were six teachers in attendance, including the Year 2 team leader and Susan in her role as the School Mathematics Leader. The relationship between Susan and members of this team appeared more relaxed, although they had been working with her for a shorter period of time than the Year 6 team. It was obvious from analysis of the planning-related discussion, recorded on video, that the Year 2 team were more experienced and had a much stronger mathematical content knowledge than the Year 6 team.

While most of the teachers at this meeting participated frequently in the discussion, it was apparent after the first four minutes [V#2, 4:24] that one teacher, (Teacher 4), was distracted and not always actively engaged in the planning. This teacher continued to view the screen on her laptop and type intermittently for a total of 27 minutes and 37 seconds during a 48-minute planning meeting suggesting that even if she was taking notes, she was not engaged in the conversation. While four teachers observed and discussed a video clip of a student explaining his work [V#2, 5:30 - 6:00], Teacher 4 shared and discussed an unrelated matter that was on her computer screen with the teacher next to her. These two teachers showed no interest in the video and chatted about unrelated work. Following this at exactly [V#2, 6:00] I observed both the team leader and the School Mathematics Leader stare across the table in silence. They refrained from making a comment, although judging by their expressions, I could sense they were annoyed.

Although other team members appeared to have a good working relationship, it was noticeable from the actions of Teacher 4, that her passive resistance caused tension between several team members, including Susan and the team leader. Video evidence showed that Teacher 4 was frequently distracted and at one stage [V#2, 8:50 - 11:38] also left the room without comment. Prior to the teacher leaving the room the teachers were involved in a lively discussion about who was teaching which lesson on which day. There was some confusion that needed clarification by the team leader. Following is a transcript of the conversation that occurred immediately prior to Teacher 4 leaving the room [V#2, 27:59 - 8:50]:

Teacher 4: No. You won't teach that lesson at all.

Teacher 2: Because I'm taking it?

Teacher 4: No. You won't teach that lesson at all. This is what is going to confuse me because …

Teacher 3: Because you've already taught it?

Teacher 4: No. Because they'll do maths tomorrow, they'll do maths on Friday

Team Leader: They'll only do maths once

Teacher 4: That'll make us one maths lesson behind

Team Leader: [Clearly explained by holding one finger at a time as she made her point].

It's taking one maths, one reading, one writing, one integrated out of your normal planner. You still

Teacher 3: [Revoices and seems to be comforting Teacher 4]. The other ones, so you still do another writing and another reading. Yeah.

Teacher 4: Yeah. That's all right, I just need to see it visually. [Looks at her laptop for a moment and then gets up and leaves the room without a comment].

On her return, Teacher 4 continued to type into her computer and occasionally added a few words to the discussion. Resistance is closely associated with relationships (Fullan, 2001). It would appear from this evidence, that Teacher 4's relationship between some members of the team was at times strained. However, Fullan (2001) points out that it is important to listen to those who oppose as sometimes they have a valid point to make, which may have been the case in this situation.

5.1.2 Supporting teachers to learn while working in classrooms: Susan.

In an interview [I#1, November 23, 2016] Susan explained that she was building the expertise of the teachers at her school in many ways. In addition to supporting teachers with planning and in professional learning team meetings which I observed, Susan also bought up at the interview several ways that she had supported teachers to learn by working with them in their classroom. Susan suggested that she tried to provide this support "as much as possible." When working with teachers in the classroom Susan explained that "it's usually modelling to begin with, and then I'll move to the team teaching." Susan then elaborated further, "so if someone says to me, can you come in and work with me specifically, it's more a one-on-one basis." Susan commented "I've actually worked with three of the teachers in here [the Year 2 team] recently and explained that one teacher "wanted to know how to teach transformations" while another teacher wanted support with bringing technology into the lesson. The third teacher wanted to know how to introduce division.

Susan went on further to describe how she had supported this particular teacher and said, “we worked on division, so looking at how you introduce division in grade two.” After a discussion with this teacher about linking division with multiplication Susan offered to model a lesson. Susan explained that “the warm-up was all about multiplication and arrays” and the lesson that followed involved students making arrays with counters. While observing the students work, according to Susan’s recall of the lesson, “we found that teachable moment. One of the kids was saying out loud, hang on, this is just an array backwards.” Susan said she was “trying to put that idea in their [students] head without … specifically [telling them]” and at the same time the teacher she was working with, according to Susan, commented “you didn’t have to tell them.” It could be inferred from this recount of a lesson that Susan supported teachers in the classroom. Susan revealed in the interview [I#1, November 23, 2016] not only did the students develop a better understanding of division, but this was a moment when she believed she had made a real difference by helping a teacher to improve their teaching of mathematics.

5.1.3 Mathematics leadership challenges experienced by Susan.

5.1.3.1 Mathematics leadership style.

During the two planning meetings I observed, teacher behaviours could suggest that there was some resistance to changes Susan had implemented and to her leadership style (Fullan, 2001). It was obvious that Susan had a clear vision of the improvements she wanted to make as a mathematics leader in her school. “Mobilising people towards a vision” (Goleman, 2000, p. 9) is a characteristic of authoritative leadership. Leaders who demonstrate an authoritative leadership style can have a positive impact on an organisation. However, a combination of different leadership styles will lead to far more effective leadership (Goleman, 2000; Fullan, 2001). The most effective leaders need to be able to switch between the authoritative, democratic, affiliative and coaching styles (Goleman, 2000). While Susan appeared to be an authoritative leader, there were times during the study when she consulted with teachers and with the team leaders, demonstrating aspects of both democratic and coaching leadership styles (Goleman, 2000). Getting the balance right was a challenge for Susan.

5.1.3.2 School Mathematics Leader confidence.

School Mathematics Leaders display “differing levels of confidence” (Millet & Johnson, 2000, p. 397), when enacting their role. Although Susan had completed her Masters in School Leadership specialising in Numeracy which she felt “was geared towards mathematics leaders”, she had no prior experience as a School Mathematics Leader and had not received any in-school training. Susan expressed uncertainty in her role with this comment, “coming in as a first-time leader … was very daunting.” She explained that she “did not know how to do” some things and mentioned that “there’s nothing that tells you how.” Susan commented that “you learn about change management, but you don’t learn about those everyday dealings” and “I think nothing can prepare you for what you face.” Gaining the respect and trust of teachers in her school was something that Susan felt was important and possibly contributed to her sense of confidence and ability to enact her leadership role. Susan explained that initially building trust was a challenge and a slow process, “but once I gained that relationship and that trust and that respect, I don’t think there was a problem.” Developing constructive relationships and relational trust with colleagues is critical to leading mathematics successfully. This view is consistent with the findings of Fullan (2001).

While interviewing and observing Susan, she appeared to be knowledgeable and confident in her role as a School Mathematics Leader. During the observations, I noticed Susan frequently shared her extensive mathematical content and pedagogical content knowledge with teachers. In the interview, Susan elaborated on incidences where she had supported teachers in their classrooms through coaching, modelling and team teaching. However, following further analysis of the video-recorded data, and as a result of several comments made during interviews, I noticed several incidents that contradicted my initial impression of Susan’s confidence while enacting her leadership role. As Susan recounted events she appeared confident in her approach, but this was not always apparent in her actions. For example, there were several occasions during the study when Susan’s confidence appeared to waiver. This insecurity occurred in one of the planning meetings, when Susan appeared to be making a joke which was followed by some laughter from teachers that could be interpreted as being polite. Susan asked [V#3, 00:58 - 1:02]:

Susan: Did everyone bring their item analysis? That ridiculous question.

The laughter from the group appeared uncomfortable. On two other occasions at a professional learning team meeting focused on NAPLAN data analysis, I observed [V#3, 01:13 - 1:20 and V#3, 1:46 - 1:50] Susan as she attempted to lighten up the meeting. These comments could indicate some nervousness or uncertainty.

> **Susan:** Who's confident reading NAPLAN data? [No response] It's okay if you're not. Anyone really confident with it? [No response] No. Perfect. [Group laughter]
>
> That's a good thing.

Then a short time later, Susan made another attempt to make a joke related to reading NAPLAN data, which was on a handout made available to the teachers. This comment indicated some uncertainty on her part:

> **Susan:** Some people like to see things in the box and whisker graph. Does everyone love those? Or if you prefer this is a line graph [raises the pitch of her voice] that show the data.

Judging from my observations Susan appeared to approach team planning and PLT meetings in a very organised and structured manner. It could be conjectured that the emphasis on being organised contributed to building her self-confidence. Meeting with team leaders prior to planning to discuss what they would cover also gave that impression. Despite years of successful teaching, teachers do not always possess the knowledge and skills to assume a leadership role (Manthei, 1992). Susan had strong MCK and PCK, teaching experience and principal support coming into the coaching and leadership role, but this did not necessarily mean that she was prepared for a collaborative leadership role with the responsibility of leading mathematics in her school (Fullan, 1993). Judging from the observations Susan was still developing constructive relationships with several teachers in her school and building her capacity to lead effectively.

5.1.4 Building professional learning communities: Susan.

It was evident that teachers at Susan's school, worked together in a community of practice developing their knowledge of the teaching and learning of mathematics. This occurred as "a process of becoming a member of a sustained community of practice," (Lave, 1991, p. 65). While several teachers in both teams I observed appeared to have limited mathematical content knowledge and pedagogical content knowledge, this might also indicate teachers who were "newcomers" (Lave & Wenger, 1991) who had not yet developed the knowledge to draw upon. In the process of working within a community of practice at Susan's school the evidence showed that these teachers were provided with the opportunity to develop their knowledge and skills (Lave, 1991).

Teachers in the first planning meeting were not yet interacting and engaging in the practice of contributing to the practices of their own community (Lave & Wegner, 1991). Susan attempted to encourage the teachers toward full participation (Lave, 1991) in the planning meeting by directing questions directly at members of the team, such as "What do you think?" [V#1, 43:06] and "What did we decide on?" [V#2, 20:55]. Although, from my observations I noticed more effort could have been made to encourage contributions from team members. It could be also be argued from the observations and video evidence that team collaboration was inconsistent. The teachers in the second team were far more collaborative and productive. As was evidenced, a group of teachers "working together on instructional issues do not necessarily constitute a community of practice" (Cobb, McClain, Lamberg & Dean, 1996, p. 14). Developing a community of practice requires members who can engage with one another (Wenger, 1998) and in the case of the first team observed, this was limited.

In summary, Susan supported teachers during the planning and professional learning team meetings that were observed, although the extent to which this was successful varied between Year level teams. The creation of structures that allowed the opportunity for teachers, supported by the School Mathematics Leader, to meet as a team, to discuss student data, and plan collaboratively, potentially provided the conditions to build an effective professional learning community.

5.2 Case Study 2: Jane

Jane taught in a modern government primary school located in an outer suburb south-west of Melbourne in Victoria, with an enrolment of close to 740 students, of which close to sixty percent were from a non-English speaking background. Jane had moved from her previous school to take up a position as a part time (0.8) School Mathematics Leader with no previous experience in leading mathematics. Jane was responsible for leading mathematics across the school from Foundation to Year 6. Jane was studying her Master of Education degree majoring in leadership and mathematics at the time of the present study, but she had no experience in leadership at a school level. Her experience developed over the four years she worked as a School Mathematics Leader.

Jane said that following the completion of her Graduate Diploma she had been "very enthused and passionate about maths." At the initial meeting, it appeared that Jane had developed a strong mathematical content (MCK) and pedagogical content knowledge

(PCK) as she described aspects of her practice. Jane appeared to be confident in her role, was able to express her thoughts clearly, and was keen to share her experiences and beliefs related to the teaching and learning of mathematics as it had evolved at her school.

It appeared that Jane supported teachers' professional learning in many ways. This case study reports how Jane supported teachers during planning and professional learning team meetings. Next some of the challenges and successes experienced by Jane in the role are examined. The case study concludes with ways in which Jane attempted to build a community of learners as she facilitated and led meetings and provided opportunities for teachers to learn how to teach mathematics by working in collaborative teams.

5.2.1 Supporting teachers to learn: Jane.

5.2.1.1 Supporting mathematics planning.

Teachers at Jane's school planned together in Year level teams. In fact, according to Jane, teams planned all curriculum areas with a teaching and learning facilitator to support teachers' professional learning. Jane was a teaching and learning facilitator for two Foundation teams. Jane explained that teachers built a close professional relationship with their facilitator as they were provided with ongoing support during planning and weekly analysis of student assessment data. Jane added that each teaching and learning facilitator "has a particular area that we lead, and we're responsible for and we deliver the professional learning around". Jane's area of responsibility was leading mathematics in the school. As part of her role as School Mathematics Leader, and teaching and learning facilitator, Jane attended four hours of planning with the two Foundation teams and taught in each Foundation classroom for four hours a week.

As a reasonably new school, Jane explained, when she began in her role the leaders had no established curriculum implementation plans, and it took them a long time to establish pedagogy and content knowledge amongst teachers. Jane provided a mathematics teaching and learning curriculum document to support planning, which she created with some teacher input. Jane explained that initially teachers were asked to write units of work to add to this document. Jane and the team leaders asked the teachers to write a unit of work based on a topic, match the mathematics curriculum outcome standards, and show a developmental sequence in the intended learning. While being interviewed [I#2, October 10, 2016] Jane said:

> We worked out that they [teachers] actually couldn't, they couldn't, they just couldn't do it. So, I kind of took the work they'd already done. We audited what they did and that was how we found out that their Chance unit looked the same … in grade one as it did in grade four. Everything was just repeating and there were gaps where they weren't covering something at all. So, we picked it out. We've just kind of written, in Prep [Foundation year] you would teach these things in each area. It's pretty much just the [curriculum] standards, but then each one has a unit of work where we've got the standards and a developmental sequence from one of our key texts and it used to have resources for each one.

Jane explained her perspective of what happened next saying:

> I did it. I pretty much did this [the Mathematics Teaching and Learning Curriculum Document that she held]. Well … we tossed and turned about this [Mathematics Curriculum Document] for a long time, because our philosophy is not that we do something for people, but actually you know sometimes in maths where you like, when do I just tell them something and when do I let it go. It was a bit like that. So, for us this was about covering the curriculum, but also it built better pedagogical content knowledge because as they followed it, they went to it for resources and now they are getting to the point where their content knowledge is higher. [I#2, October 10, 2016]

Although initially, as Jane said, "I wrote the curriculum, which I wasn't going to do," she also made the point that she felt, as time went on, there was a need for "gradual release of responsibility" for teachers. Jane explained that eventually she took out the detailed resources from the curriculum document and just included a basic coversheet for each topic. The idea in current use, according to Jane, was for teachers "to pick what is relevant for my Year level." Creating this document, according to Jane was one way to ensure teachers were covering the expected curriculum and it built their mathematical content knowledge. According to Fullan (2020) effective leaders make people feel like they can tackle the most difficult problems, which in this case could include the planning of mathematics lessons. This type of authoritative leadership is powerful when mobilising people towards a long-term vision and "when a clear direction is needed" (Goleman, 2000, p. 9). However, spending time to get teachers buy-in in a democratic style according to Goleman is more likely to build "trust, respect and commitment," (Goleman, 2000, p.10) but this can take time, and as Jane admitted in an interview [I#3, October 27, 2016], "at the end of the day, they've just got to get their planning done."

5.2.1.2 Foundation planning meeting—Team 1.

Jane mentioned the fact that staff turnover at her school was high, and many of the newly appointed teachers were graduates. She expressed her opinion that, "teacher graduates are coming in with less and less tangible knowledge and skills." Limited mathematics curriculum knowledge was particularly noticeable during the planning sessions I observed. Jane, as the School Mathematics Leader was present, a team leader and two other teachers. It was interesting to note that Jane and the team leader were engaged in most of the discussion around planning for this team. There was a total of 581 comments made during the meeting, 213 comments were made by Jane, 259 comments were made by the team leader, 85 by another teacher (Teacher 3) and 24 by the first-year graduate during a 54:41-minute planning meeting. This evidence shows that while Teacher 3 and the graduate teacher may have been actively listening to the exchange of ideas, they were participating in less than 20% of the discussion. The lack of contribution by these teachers to the discussion on how they were going to link mathematics to their inquiry and suggestions of lessons for their weekly planning may have been due to inexperience and limited mathematical content knowledge. This paucity of contributions may also have been the result of not enough encouragement or perhaps seeing their ideas as not being valued in this situation.

The limited extent of teachers' mathematics content knowledge and pedagogical content knowledge was evident during each observation. This limited knowledge was also evident in the number of questions that were asked about details related to possible mathematics lessons and answered by team members. At this planning meeting, I noted a total of 84 questions asked by team members in attendance. Of the 84 questions, the team leader answered 45, Jane answered 21, twelve were answered by Teacher 3 and six by the graduate teacher. Interestingly, only one question was directly addressed to the graduate teacher by name, and she rarely contributed to the discussion. Being in her first year at this school or as "newcomer" in this community of practice (Lave & Wenger, 1991), it could be inferred that she preferred to listen to the discussion at this stage. On the occasion, when she did respond to the one question that was directed to her, she made a very valid point related to the sequence of lessons. Jane asked [V#1, 45:21 - 45:25]:

Jane: What do you think xxx?

Graduate: That's what I thought too. Do 'The Doorbell Rang' first, because in a way the personal sharing is a bit more abstract.

The reason for limited contributions to the discussion might have been because the teachers felt too intimidated by the team leader or the School Mathematics Leader to offer their ideas. Teachers might have also lacked confidence or were worried "about admitting they don't know or understand for fear of colleagues'… reactions" (Bransford et al., 2000, p. 195).

Although it appeared the first-year graduate teacher lacked confidence and mathematics pedagogical content knowledge, I also noticed that Teacher 3 demonstrated a degree of uncertainty in her manner, and in the comments she made. According to Jane, Teacher 3 "was … very scared of maths, didn't like it, didn't know how to do it, [and] didn't feel comfortable with it." Jane suggested that Teacher 3 needed further support this year because she had moved to a different Year level. The following transcript provides some evidence of the extent of the mathematical knowledge for teaching (Ball et al., 2008) of the teachers in this team, and the difficulty they had of knowing how to plan for effective mathematics teaching. Such knowledge is a critical issue in teacher planning (Davidson, 2016). Interestingly, the graduate teacher did not contribute to this part of the discussion, and judging from Teacher 3's comment, she did not initially understand the approach advocated by Jane, which was teaching through problem solving rather than teaching a unit on problem solving [V#1, 30:06 - 31:30]:

Teacher 3: Shall we stick to problem solving until we do our PLT? Map out.

Team Leader: Perhaps. Perhaps. Yep.

Teacher 3: How many lessons are there?

Team Leader: [Excitedly jumps in her seat] I found a couple of new problems actually, Nrich I discovered Nrich again!

Jane: Re-discovered.

Team Leader: Actually, that was The Doorbell Rang one. So, I wasn't thinking so much [about] that. Although do we do something like that to get some …

Jane: Do your multiplicative thinking?

Team Leader: Yeah, some pre-assessment stuff for multiplicative thinking?

Jane: I think it will be really good if you have not just problem solving [indicates inverted commas with her hands in the air] because we want them doing problem solving all the time every day. And if you think about proficiencies you can be gathering data on problem solving and, on their fluency, and on their understanding and on their reasoning, but through a context. [30:40]

Team Leader: So, we are working on multiplicative thinking through problem solving. Right?

Jane: Only because you are naming it. Yesterday when I was in your class I could walk around and go yeah that kid's counting by ones or that kid is, but I don't think it was explicit enough that they knew that was what they were supposed to be doing, or you know what they were aiming for, or I didn't know what to collect data on. This way it just gives you a bit more structure and you're still using those rich tasks and questions.

Team Leader: So, shall we try The Doorbell Rang? I'll show you. [Indicates to others to look at the television screen.]

While the discussion was occurring, I noticed Jane's reaction [V#1, 30:06 - 30:40]. To begin, she sat with her chin on her hand and did not respond immediately. After some thought and some initial holding back, I noticed she finally stepped in and shared her thoughts on teaching problem solving in a context, not just as a topic. She admitted there were times when "I still can't help myself from blurting out - I think you should do this." Jane acknowledged "I was really conscious at the start in my role that I was always telling … I was really aware of that."

Although Jane suggested "I am getting much better at waiting. But sometimes, they just don't know what they don't know," and judging from the video evidence of the planning meeting this appeared to be one occasion when Jane needed to step in. As she explained in an interview [I#3, October 27, 2016], there were "bits they just didn't have," and "some gaps in knowledge where I have to go hey, this is the sequence, you've got to get this in." On several occasions, I also noticed as a means of encouraging teachers to make a decision, Jane purposefully asked a question and held back from sharing her opinion. For example, on one occasion the team leader asked, "So what is the learning focus? The learning focus is about multiplicative thinking" and Jane replied, "I don't know. Is it?" [V#1, 37:55]. On this occasion Jane sat quietly without adding any more, although this did not always occur.

It was also interesting to observe long periods of silence from some teachers in the team. Jane and the team leader continually interacted throughout the meeting, with only occasional comments from the other two teachers. Discussion occurred between Jane and the team leader for a total of 15:48 minutes, which is close to a quarter of the 54:41-minute meeting. While they discussed possible ideas, Jane made some suggestions of possibilities and inquiry links as she recorded these connections on a large whiteboard. She recorded the inquiry topics for the term, making the links to mathematics, and in her words, "making sure that we've got the rigour in the maths" [V#1, 23:01]. Jane frequently asked questions to prompt the team members, such as, "So multiplicative thinking which looks like what in Prep?" [V#1, 11:30] and "What's in maths this week?" [V#1, 23:37] or "Where are you starting?" [V#1, 23:45] These questions kept the planning session flowing and encouraged the teachers in this team to stay focused. As Jane commented, "sometimes you can let them go, but other times you have to go, no, I don't want you to do a unit on problem solving. I want problem solving in your practice." She also pointed out "you have to drag them along a bit, but they're good teachers and they want the best." Although it appeared that the mathematics planning was not always what Jane considered "the best" and she believed that she needed to step in and give the team more direction Jane continued to challenge her team while supporting them.

It was clear that this team used a variety of resources, including computer websites and Maths 300. The video evidence [V#1, 34:07 - 34:20] showed Teacher 3 describing a lesson from this resource. Jane explained Teacher 3, who "didn't feel confident," had previously been involved in a project working with a mathematics consultant, and this is where she had experienced Maths 300, which she often used:

> This was what she needed. We had some success with modelling that, and from there every lesson was, that was her go to. She knew they worked. She always had a script if she needed it, that she could go off when she felt comfortable. That was a big turning point for her.

While the team leader offered several suggestions of possible lessons and Teacher 3 shared the Cookie Count lesson as well as making a few related suggestions, the first-year graduate teacher did not contribute any ideas at all. Discussion of the possible sequence of lessons based on division continued for nearly 23 minutes [V#1, 31:26 - 54:04]. During this time the team leader referred to previous data on where students were and how they could cater for students. Interestingly, Teacher 3 made her greatest contribution to the discussion during this time. Teacher 3 was able to reflect back on how she had implemented the Cookie Count lesson in a previous year and communicated her ideas. Teacher 3's increased confidence at that moment was apparent, and the number of contributions she made to the discussion increased during this time.

As the planning meeting continued Jane and the teachers in the Year Foundation team discussed a possible sequence of lessons. At one stage Teacher 3 suggested they could swap an activity, but was interrupted by the team leader who insisted she knew best and said [V#1, 44:29]:

> **Team Leader:** "No. No. We could still act it out."
>
> **Jane:** [Intervened] You just don't want them getting bored and doing the same thing.
>
> **Team Leader:** No. This is still referring to the text. Shall we act it out. So, this is giving them, the answer and they are sort of checking the book. Aren't they? That's the sort of … Shall I go and get the book? I'll go and get the book.

Teacher 3 again picked up her notes, which reminded her of the lesson implementation. Video evidence [V#1, 44:48] then showed as the team leader left the room to find the big book, Teacher 3, Jane, and the graduate teacher discussed the sequencing of lessons that would work best, and which made sense to them. They all agreed, and Teacher 3 shared this with the team leader as she returned. She appeared to politely agree to follow their suggestions and they continued planning.

5.2.1.3 Foundation planning meeting—Team 2.

During an observation of another Foundation team (Team 2) I noticed the extent of support Jane provided for this team. Jane, as the School Mathematics Leader was present, a team leader and two other teachers. Jane continued to ask questions of the team to prompt, and to guide their choice of tasks and tools. The following example includes some of the discussion and demonstrates how Jane supported this team [V#3, 17:21 - 18:59]:

Team Leader: I think this time we need to be really clear on what exactly we are measuring too because remember … when we said measure the chair, they did like a triangle all around. It was like they were doing the perimeter.

Teacher 2: Yeah. They measured the seat. They measured one leg. They measured the whole chair. So, it was good. We got lots of different things.

Jane: So, if you are thinking about problem solving. What's the problem you could give them that would make it more focused, because it sounds like in that case, they just didn't have a question, or they weren't solving a problem?

Team Leader: No. They weren't. They weren't.

Teacher 1: No

Teacher 2: I'm thinking of how many matchsticks does it take to measure this? It's still specific so they get to that.

Team Leader: [Nodded her head and appeared to agree] Um

Jane: The other thing is you can't say matchsticks because some aren't ready. So, if you think about that. What's your core task so the kids who are ready can do it that way, but the kids who aren't can be doing direct comparisons and going this is longer than this. [She demonstrates using a pen and phone]

Team Leader: Yes

Teacher 2: Yeah. So,

[Silence from 18:15 - 18:30 while teachers were all thinking]

Teacher 1: So basically, it needs to be really open-ended. Doesn't it? If you are going to take it from where they're at.

Jane: Um. Well, the problem is that they have got to be measuring something or comparing different things to say which is longer. It's just that some of them need to able to just hold them, and go that one, and others you want them to be justifying it with measuring it. You know, how much longer is it might be a prompt, so those kids need to be able to go, it's five matchsticks longer than this.

Team Leader: Ohhh.

This discussion continued for quite some time about a suitable task and suitable materials students could use when learning to measure length. I noticed the mathematical pedagogical content knowledge of members of this team or "knowledge-o*f*-practice" (Cochran-Smith & Lytle, 1999) that was required to plan an open-ended measurement task was limited. Throughout the discussion, Jane continued to prompt teachers in this team. I noticed the whole team found it difficult to choose and design an appropriate task, suggest suitable materials students could use, and make the mathematical focus clear (McDonough, 2003) so that students could investigate and measure the length of objects. As this team continued to plan, this transcript provides further evidence of the discussion that took place [V#3, 20:35 - 21:47]:

Team Leader: Originally, I was thinking who has got the, because all of our pencils are different lengths because of the way they sharpen them … Who has got the longest pencil and why? Then that could be a prompt as well, or how do you know? Prove to me that that's longer than that one, could be another way.

Teacher 2: I don't know what longer means. Show me.

Jane: And then you can write down all the strategies that they used. So, one way I can prove something is longer or shorter is I can hold them next to each other and show you. What would be another way? What if they weren't together and you can just start recording it.

Team Leader: Yeah. I think I like that. [referring to Teacher 2's suggestion]

Jane: Write it in. … Learning focus.

Team Leader: I don't like starting with that one. I like coming back to it.

Jane: What the learning focus?

Team Leader: Yeah. I find it hard. I don't know why.

Jane: Don't you need to know what they want to learn before. Otherwise, you are doing an activity without reinforcing the leaning.

Team Leader: Yeah. True.

Teacher 2: How to compare the size of objects.

Teacher 1: [Very slowly and tentatively added] Using informal measurements.

Teacher 2: And justifying using informal.

Jane: Measure and justify.

Teacher 2: The length of different objects.

Team Leader: Am I getting it all? Using informal units. You guys can just jump in and justify our answers.

Although the team leader mentioned that she had completed the reading Jane had suggested before planning, teachers did not use any resource texts to support their planning, which could possibly have provided them with the background knowledge needed. From the video evidence, [V#3] there was a box of teacher reference materials on the table, but surprisingly not one of the teachers referred to these or appeared to have brought their Mathematics Teaching and Learning Curriculum Document, compiled by Jane, to the meeting. Whereas the teachers that I observed in the initial planning session all had their Mathematics Teaching and Learning Curriculum Documents and several resource books and printed lesson plans from Maths 300, which they referred to these frequently.

5.2.2 Mathematics leadership challenges experienced by Jane.

5.2.2.1 Relationships.

During Team 2's planning meeting, it was obvious that a certain tension existed between Teacher 1 and those in attendance, but particularly between the team leader and Teacher 1. The team leader rarely looked at or spoke directly to Teacher 1. During the 49:07-minute planning meeting, the team leader directed questions to Teacher 1 on eight occasions. Video evidence clearly showed that each time the team leader directed a question to Teacher 1 she never once referred to her by name. Teacher 1 did not respond to three of these questions, which were either answered by someone else or repeated. The team leader appeared uncomfortable when looking directly at Teacher 1 and rarely made eye contact.

The Foundation team planned a measurement topic for most of the session. During the 49:07-minute planning session, video evidence showed the majority of the discussion was between Jane, the team leader, and one other male teacher (Teacher 2). There were 527 comments made throughout the meeting. The team leader spoke on 188 occasions, Teacher 2 spoke 138 times and Jane spoke on 149 occasions. Teacher 1 spoke a total of 52 times, which was close to 10% of the total number of comments made. Of these comments, only one was a suggestion that could possibly be used in the weekly planning. Teacher 1's contributions consisted predominantly of a nod of the head in agreement, repetition of other teachers' phrases and "Uh um" responses. On the one occasion when Teacher 1 actually suggested an idea for planning as a result of being questioned, the team leader did not take this up. Interestingly, the School Mathematics Leader had suggested this same idea several minutes before this occurred [V#3, 19:47 - 20:01]. From the initial time Teacher 1 was asked her thoughts by the team leader, it took 27 seconds for her to respond, as this evidence shows.

As the team leader typed into the planning document, she asked members of her team [V#3, 22:45 - 23:32]:

> **Team leader**: What are you guys thinking? [Looked at both teachers and continued to talk.] I feel like if we have two different things it might be easier for them, but the pencil might be a little more abstract.
>
> **Team leader**: What are you thinking? [The team leader looked directly at Teacher 1 as she asked this question but did not use a name. Then she glanced across at Teacher 2 and back and waited for a response. Teacher 1 was engaged in looking at her computer screen and did not respond immediately. Then Teacher 1 looked up and repeatedly tapped her long fingernails on the table. There was silence for seven seconds.]
>
> **Teacher 2:** It's not going to be too abstract because they are going to have it in front of them. There are so many different size pencils.
>
> **Team leader:** Yeah. [Repeats the question to Teacher 1] What are you thinking? Are the pencils okay?
>
> [As she repeated this question she nodded while Teacher 1 continued to tap her fingernails.] [23:12]

> **Teacher 1**: Yeah. I think so. The only other thing we could do is we could cut different lengths of string or wool or whatever, cut different extra lengths but I think the pencils is okay but …
>
> **Jane**: So, are they all going to have their pencils out?
>
> **Team Leader:** I think there could be a range.

Video evidence showed the team leader directed the majority of her questions to Jane and Teacher 2 and relied on them to contribute to a large extent. Although Teacher 1 appeared to be listening attentively and at times nod in agreement, she continued to eat and drink at frequent intervals throughout the meeting. Resistant behaviours (Fullan, 2001) were observed during most of the meeting. Jane commented that Teacher 1 "has a more traditional approach and has a very teacher directed model of teaching." This might have contributed to the observed behaviour and although Teacher 1 appeared to agree on what was planned by saying, "Yes" or "Uh um" and nodding her head, her limited contribution and involvement in the discussion might also have been based on limited mathematical pedagogical content knowledge or not feeling her opinions were valued. An example of this was obvious when Teacher 1 slowly and tentatively added the comment "using informal measurements" to the planning discussion. [This can be seen in a later transcript]

While "relationships make the difference" (Fullan, 2001, p. 51), the relationships between Teacher 1 and Jane, and Teacher 1 and her team leader were strained as the video evidence and Teacher 1's disengagement in the meeting clearly showed. This tension was recorded by Jane in a prompted written reflection following another planning meeting. Jane wrote [WR#1, J]:

> One member who is new to our school has a very teacher directed model of teaching said she understood and agreed, but I need to follow up next week and ensure that the design has been enacted as planned. The two other members have made huge growth in the way they plan and teach maths throughout term three and will hopefully be strong enough to build the capacity of the other member.

Further evidence of the strained relationship was apparent in an interview [I#3, October 27, 2016] comment made by Jane. She explained, referring to Teacher 1, "she's very different when I'm around. She has some kind of authority, something, which is weird, because I don't feel like that here ever. I don't feel like I'm in any different position of power than anyone else.” Jane suggested, “sometimes when people come in, you can tell that’s what they’re used to.” Jane also pointed out that “there’s a lot of work going on there” and referred to open-to-learning conversations (Robinson, 2017) as one strategy being used to improve the relationships. It appeared as if Teacher 1 was showing signs of resistance and was not contributing as a result of this tension between the team leader, Jane and herself. Although it may also be possible to learn something from resisters, as they can often tell us something important (Fullan, 2001), the opportunity to investigate the source of the resistance in this situation was not an option in the present study. Appreciating resistance is a sign of effective leadership and as evidenced in Jane’s written reflection, Jane was aware of Teacher 1s attitude. Jane admitted that, “some people are in shellshock when they come here for the first year, so we leave them alone for a little while, because it’s a bit overwhelming.” As an inquiry-based school some teachers struggle with the idea of planning and teaching through authentic contexts. Jane explained “most people, even though they’re not enthusiastic, all of them see the purpose in why we’re doing what we’re doing” but it does cause some issues. Fullan made the point that, “even when things appear to be working, the supposed success may be a function of merely superficial compliance” (p. 43). This superficial compliance might have been the case in Jane’s school.

5.2.2.2 Mathematics leadership.

On several occasions Jane talked about her vision for mathematics in the school and how important it was. During the first interview [I#1, October 13, 2016], Jane explained, “the vision I have for this school is just not what is happening right now - and it is probably far away.” However, she explained that she understood that building teacher expertise would take time and suggested that “we are going to have to do some stuff, that maybe isn’t in line with my beliefs.” In other words, Jane realised that she would need to take things slowly. She felt the need to:

> Step back and go developmentally this is where my staff are at … we’ve built their pedagogy. They came out as grads [novice teachers]. They didn’t know anything, anything about it. You know, same lesson being taught at four-year levels in a row kind of stuff, so you really have to step back and go “Wow”. Here everything is co-written and co-constructed but to be able to go they’re not really ready. They don’t have what they need, to do that.

Jane saw this ability to “kind of hit their needs, even when it’s not really where I want to be right now” as a success. During another interview [I#4, March 3, 2017] Jane explained the leaders at her school are “very big at respecting people’s learning journey and people’s place on that.” Jane also mentioned that at the beginning of the year when new teachers come into the school, she will make a point of explaining the leadership team’s vision:

> My normal phase is to say to people that this is our vision, this is where we’re going, and if you teach in this way down here that’s okay, but your ultimate goal is here [pointing down and then up]. If it’s not there, you’re in the wrong place.

This was a clear message asking teachers to aim high, but also made the point that the approach at this school was a little different than teachers might have experienced previously.

As an inquiry-based school where teachers aim to teach all concepts through authentic contexts, (artefact 2) Jane added, there are certain non-negotiables based on the school philosophy of teaching mathematics through inquiry that teachers need to follow. She spoke about the importance of teachers following and believing in this philosophy of the school, and “keeping the belief that it [the inquiry approach] does work.” Jane explained “everything we do looks like that” and teachers “have to have success with it to believe it,” which is our challenge. She mentioned “graduates are easier because they actually don’t have any idea. I just want to do anything … I’ll believe your philosophy … they come in, they’re fresh and we can mould them.” Whereas other teachers, “who came from somewhere else” often with a “more traditional view of teaching” and “who already have a pre-conceived idea and it doesn’t align with what we do here,” find it difficult to adjust. Jane pointed out, “people who have really strong mental models of what teaching maths is” sometimes struggle with the inquiry mathematics approach.

An authoritative leader articulates a groups’ vision, which in this case was strongly expressed by Jane. A “come with me” (Goleman, 2000, p. 9) attitude of authoritative leadership motivates people, however there is also a need to build consensus through participation (Fullan, 2001). A democratic leader will build buy-in or consensus, which in turn “builds trust, respect and commitment” (Goleman, 2000, p. 10). There were occasions when Jane attempted to spend time getting people’s ideas. Leaders who rely on a blend of authoritative, affiliative, democratic and coaching leadership styles and master all four styles have a more positive effect on climate, which leads to the better results (Goleman, 2000). It was obvious that Jane demonstrated all four of these leadership styles to some extent.

5.2.2.3 Pedagogical content knowledge of team leaders.

During an observation of the Foundation team planning meetings and a professional learning team (PLT) meeting, it appeared that not only was the mathematical content and pedagogical content knowledge of many teachers in Jane's school limited, but I also noticed team leaders needed support. As each team leader attempted to lead the planning, they required a large degree of support from Jane. Several comments from the team leader that indicated a lack of confidence and mathematical content knowledge are apparent in this transcript [V#1, 37:51 - 39:03]:

> **Team Leader**: So, what is the learning focus? The learning focus is about multiplicative thinking.
>
> **Jane**: I don't know. Is it?
>
> **Team Leader:** We are learning to [looks at the mathematics curriculum document and reads aloud] represent practical situations to model sharing. We are learning to …
>
> **Teacher 3**: Well on here [looking at a Maths 300 lesson as a resource] there's whole number operations. These are the outcomes, counting strategies.
>
> **Jane**: What are you looking at? [Teacher 3 holds up page from a Maths 300 lesson] Oh Cookie Count.
>
> **Teacher** 3: The Cookie Count. Oh. Sorry are we talking about Animal Legs?
>
> **Jane**: No. What were you talking about?
>
> **Team Leader:** No. No. I'm onto Doorbell Rang
>
> **Teacher 3:** Multiples, fair shares, sharing, and then like fractions, remainders
>
> **Jane:** What do you want them to know?
>
> **Team Leader:** We are learning strategies for sharing equally. How did I go?
>
> **Jane:** I don't know. How did you go?

Team Leader: Because I always get stumped when you say, what are they doing? What's the difference between, what are they doing and what are they learning?

Jane: The intention is not what they are doing, so it's not learning to share cookies. What life skill are they learning?

Team Leader: No. We're learning to share things equally. Yeah. OK? [laughs] The conversation discussing the learning intention or focus of the lesson continued for close to another minute as the Team Leader typed on her computer [V#1, 39:38 - 40:29]:

Team Leader: So, we are learning to. We are learning strategies. Do they know that word? Ways. We could unpack that. We are learning different ways to share things equally. [She laughs]

Jane: Are they learning different ways?

Graduate Teacher: We are learning how to share equally. To share things equally with others.

Team Leader: We are learning how to share things equally because they could come up with different strategies themselves. We are learning how to share things equally. Share things equally. How things can be shared equally.

Jane: That's okay. [Laughs] Move on

5.2.2.4 Working in classrooms.

Jane admitted that because of the allocation of teaching roles and responsibilities, at the time of the study she did not have the opportunity to visit classrooms across the school. This "means half of the time I don't know what [teachers] are doing in maths or I'm not teaching maths." As the School Mathematics Leader, Jane suggested, "in some ways I think it would be good to know what is happening across the school more." Jane admitted, "I used to do a coaching thing and sometimes I think that would help, if I could find out what everyone does in maths, but I tried it and it didn't work." Jane admitted that one of the reasons it didn't work at that stage was because her coaching skills were not strong enough to support teacher needs adequately.

Initially Jane was employed at this school as a numeracy coach to work in classrooms with different teams for four-week cycles. However, Jane believed that teachers did not have the mathematics content knowledge or the pedagogy. She explained that "you just didn't get what you needed to get, and we needed to build teacher capacity in everything and so we actually needed to be connected to a certain group." Jane also admitted, "I wasn't strong enough yet, in my own coaching skills." Jane explained that she wanted to develop her coaching skills and was aware that leaders are more likely to achieve success when coaching teachers who understand their weaknesses and are motivated to improve. However, coaching can fail if the leader lacks expertise to support the teacher (Goleman, 2000). Jane admitted this was the case earlier in her mathematics leadership role. In an interview [I#3, October 27, 2016], Jane stated:

> A coach is [used] when someone's got most of the stuff happening and … they've got to get to the next level, or they've got to fine tune something, or there's a thing missing from their practice. Whereas where we were back then, was not good. They needed a consultant. They needed pedagogy, they weren't doing professional reading, they didn't have a lesson structure, they had no assessment, they didn't know.

Also, a coaching style (Goleman, 2000) does not work when people are resistant to change, which may have been the case with some of the teachers at Jane's school. Jane felt it was difficult trying to "build rapport and then create this professional learning and then trying to address it … it just didn't work." According to Jane you would try and coach one thing and "you would find eight other things that needed to be worked on."

In an interview [I#1, October 13, 2016], Jane explained through a funding grant her school was able to employ an external coach and as a result, "teams were learning what they needed to learn." Interestingly, as the coach worked with teams, Jane explained that she joined the team to build her own expertise. "I was actually learning how to be a coach from her because I sat in that maths project." In fact, following Jane's appointment, to further develop her leadership skills, Jane also decided to enrol in her Master of Education degree based on leadership. This course included a mathematics component. This evidence showed that Jane continued to develop her knowledge and expertise in mathematics in a variety of ways, yet the school continued to engage an external mathematics coach. Jane explained this was a way of targeting specific needs based on a particular focus and provided support for teachers to build their pedagogical content knowledge. Coaching from an external coach continued on a long-term basis. As Jane pointed out, “we ended up just engaging the coach forever. She’s here every single term for four weeks but working with a different team.” There was an obvious need to develop mathematics knowledge for teaching, based on the observation and video evidence, and Jane’s school engaged both an external coach and a School Mathematics Leader to do this.

5.2.3 Success in leading mathematics: Jane.

5.2.3.1 Relationship with the principal.

During an interview [I#1, October 13, 2016] Jane explained, “I have a very strong leader who I consider to be a mentor and she’s known for that … she kind of likes that, because we do things a bit differently.” Jane pointed out “I’ve always felt trust and we’re very open here to make mistakes. There are no “mistakes” - everything is learning.” Jane suggested that her relationship with her principal was a very strong one that began at a previous school. When Jane began in her role as School Mathematics Leader, she came with no leadership experience at all. Despite this, Jane explained during the interview, her principal once said to her, “I’m willing to wait for what’s in there” which she went on further to explain [I#1, October 13, 2016]:

> You know because she kind of wants the ideas that you have of someone who doesn’t know how it’s supposed to be done … and she knows it might take you a while to get there, but she has faith that you will get there and she kind of mentors you there. That’s been exciting.

Jane added:

> She’s amazing and I think she did for me what I just talked about with the staff. Not in any way [pushing] what I know her vision perhaps was, but just being patient enough and she’s so good at - which I’m still not mastering, … She is very good at not doing that so [she says], “What are you doing with this?” and “Let’s sit down and map that out together,” or “What do you want?” There’s lots of rich conversations, but she doesn’t take over. I feel I have complete trust, but I could walk into her office at any time and she’ll give me an hour, or she will say, “Hey we need to chat about this” or “You don’t have an assessment schedule,” but it’s never a “You should have done this”, or you know she will just give you what you need as much or as little as you need. She’s pretty cool.

Jane pointed out that her principal used a very distributed leadership style and suggested that not much goes to her. “She kind of makes us do it all down here because we’re the ones working with them” [the teachers]. Distributed leadership is described as “a form of collective agency incorporating the activities of many individuals in a school who work at mobilizing and guiding other teachers in the process of instructional change” (Spillane et al., 2001, as cited in Harris, 2004, p. 14). This appeared to be the case at Jane’s school. Some of the structures put in place, including the teaching and learning facilitators, supported this concept. The evidence demonstrated the strong influence Jane’s principal had in the school. Together Jane and her principal mobilised teachers towards a vision, a sign of an authoritative leadership (Goleman, 2000) while at the same time making a positive difference to others and being “guided by moral purpose” (Fullan, p. 9, 2020).

5.2.4 Building professional learning communities: Jane.

Professional Learning Community (PLC) meetings (described as Professional Learning Team meetings at most other schools) according to Jane, are “normally run by someone [at her school], unless there is a need that isn’t met here, then we will go beyond.” Jane also made the point, “we’ll draw on evidence research [and] use our experts in that way.” Jane explained, the leadership team facilitates and delivers professional learning, which “is onsite and ongoing.” Jane pointed out, “that’s how we get the professional learning culture we get.” As a leadership team “we gather the data, we analyse it, we collaborate, and we plan the professional learning together” and “we all learn from each other.” Jane described this as “pretty unique and super supportive.”

As Jane contributed towards building professional learning communities, she mobilised teachers at her school towards the school vision of how best to teach mathematics (Goleman, 2000). Her enthusiasm and passion for leading mathematics were apparent. During an observation of a Professional Learning Community (PLC) meeting I heard Jane remind teachers, when she first started at this school, how everything was inquiry and how they were teaching everything through that approach to learning. Then she commented [V#2, 4:49 – 5:36]:

> But then we realised that the maths developmental sequences weren’t being valued so we were sometimes teaching the same content over and over again or we weren’t going deeply into the sequence of how to develop that big idea or that content area. So, we really broke it down and started writing units of work which led to our curriculum, and we had experts come in … to help us with that and then we ended

> up almost separating it completely then, and teaching one thing at a time, and then we tried doing three [lessons of number a week and] two [lessons on measurement]. Let's introduce two things and then try to combine them together when we're ready for it and now we really need to get into this century and join them back together.

Jane shared a clear vision with the staff. Of all leadership styles, authoritative leadership has the most positive effect (Goleman, 2000). "By framing the individual tasks within a grand vision, the authoritative leader defines standards that revolve around the vision" (Goleman, 2000, p. 8) and this grand vision at Jane's school was clear in her mind.

The building of a strong professional learning community was obvious at Jane's school and as a School Mathematics Leader, Jane was a strong link. However, concerns were expressed by Jane with the high turnover of staff each year, especially leaders. Jane explained "we're actually really good at building leadership capacity, but then we don't have enough jobs to keep them, so they all go." According to Jane when the leaders left, the teachers "who stood up to be our mentor leaders, [didn't] … seem to be sharing the vision" and "we're wondering if [in previous years] they were just doing what their leader was doing, rather than owning this is what the maths is." In other words, being compliant. According to Jane, at the moment "we don't have a lot of strong leaders leading the teams to show them how to get there." Jane believed that "building our leadership team's capacity, and then trusting them to build the capacity of teams was a starting point," and commented "if we skill them up we should see flow-on. We're just going to have to be a bit more strategic about how we do it." Elements of authoritative leadership such as enthusiasm, optimism and clarity of vision all help inspire people to keep on going (Fullan, 2001). Although the affiliative leader who focuses on building relationships (Fullan, 2001) and the leader who coaches and "helps people develop and invests in their capacity building" (Goleman, 2000, as cited in Fullan, 2001, p. 41) are also important in these situations.

In summary as was observed in the present study, Jane supported teachers during the planning sessions by providing curriculum related documents and resources, posing prompting questions to encourage teachers to think and sometimes telling teachers what she believed they needed to do. While Jane suggested that she was really conscious of always telling and now made an effort to hold back, judging from the number of comments Jane made in the planning sessions I observed I would question the fact that she was holding back from telling. Although as she admitted this was something that she was working on.

While Jane experienced several challenges in her role, through hard work and dedication she was able to promote the elements of effective mathematics teaching and learning throughout her school. Having the strong support of her principal and knowing that she was a valued member of a supportive leadership team contributed to Jane's sense of self-efficacy. As a result of external professional learning and many opportunities to continually learn by doing (Du Four et al., 2010) Jane developed a strong pedagogical content knowledge which contributed towards building her self-confidence and her ability to lead mathematics as a School Mathematics Leader.

The creation of structures that allowed the opportunity for teachers to be supported by the School Mathematics Leader, to meet as a team, to discuss student data, and plan collaboratively, potentially provided the conditions to build an effective professional learning community.

5.3 Case Study 3: Amy

Amy was a School Mathematics Leader in a very large school with close to 1000 students, located in an outer suburb south-east of Melbourne in Victoria. Amy worked three days a week leading mathematics in her school as part of a team of four trained Primary Mathematics Specialist teachers (Department of Education and Training, 2017a). At the initial interview, Amy explained that in 2012, the mathematics team became part of a mentoring program, which at the time of the interview, was in its fifth year. While the *Primary Mathematics Specialist* (DET, 2017a) teachers' program was a two-year project, the team at Amy's school were fortunate to have been able to continue working for several years beyond the initiative, which indicated the value her school placed on the work of the mathematics leaders.

In addition to the professional learning provided in school and the *Primary Mathematics Specialist* (DET, 2017a) training, Amy had also completed the Bastow Leading Numeracy (DEECD, 2014) course, the Foundation to Year 6 Extending Mathematical Understanding (EMU) Intervention Program, and her Graduate Certificate in Education related to mathematics. Amy had developed a wealth of mathematical content knowledge (MCK) and had experienced a wide range of opportunities to develop her mathematical pedagogical content knowledge (PCK), which was an advantage when working with teachers in her school. Amy appeared to be knowledgeable, confident, able to express her thoughts clearly, and very passionate about the teaching and learning of mathematics.

Amy's data revealed, how in her role as one of a team of School Mathematics Leaders, she supported teachers' professional learning. This case study begins with describing some of the ways in which Amy supported teachers in their classrooms and during professional learning team meetings. Next some of the challenges and successes experienced by Amy are described, together with evidence of how she attempted to build a community of learners as she supported teachers during professional learning team meetings.

5.3.1 Supporting teachers to learn: Amy.

Based on the interviews and video evidence provided, Amy and members of her team spent the majority of their time enacting the School Mathematics Leader role working in classrooms, supporting individual teachers with planning, supporting teachers in professional learning teams (PLTs) and facilitating professional development. Part of the role of the School Mathematics Leaders was to build teacher expertise through mentoring. Amy explained that each year teachers at her school were allocated either an English or mathematics mentor based on their responses to a survey, which included "information about what year level they will be working on, what mentors they've had in the past, what mentor they would really like to have, and what they want their focus to be" [V#2, 5:28 - 5:35]. The teachers worked with their mentor for an hour of planning and an hour in the classroom each week, and according to Amy, "how that looks is up to them" [V#2, 2:43 - 2:44]. She pointed out that some teachers "want to implement something in the classroom or they might want help with data or whatever it might be," or at times mentors "might model if that's what [teachers] want" and others "might … take groups" in the classroom. Amy explained, "because here we've never run a whole school program for anything … Everyone does their own kind of thing. There are very few things around that you can see that are consistent in all classrooms" [V#2, 30:23 - 30:34]. According to Amy her principal's philosophy "has always been everyone should be teaching whatever it is, like the shared expectations, [and] by the end of the year [students] need to know all this, but how you teach that is completely up to you" [V#2, 31:12 - 31:21]. As a consequence, most teachers worked in isolation, although some had the support of the School Mathematics Leaders.

5.3.1.1 Supporting mathematics planning.

Although in Australia, it is common for primary teachers to work in a team to plan mathematics lessons and units of work (Davidson, 2016), the teachers at Amy's school planned individually. Amy pointed out that "none of the teams [at her school] plan together," and although she suggested that she had "heard teachers in this school say … that's one thing we're missing, … collaborative planning." Amy agreed and said that "we have never done that [collaborative planning before]." Amy believed that some of the teachers at her school "haven't been anywhere else and experienced anything else," and "haven't compared it, and just look at it as I would have to give up an hour of my APT [Allocated Preparation Time], when would I get everything done sort of thing." According to DuFour and Marzano "it is not uncommon for teachers to rail against any schedule that substitutes even one hour of individual planning time for collaborative planning time" (2011, p. 74). Amy believed "it would be a timetabling nightmare, to be honest. But that doesn't mean it can't be done." She explained that six or seven grades would need to plan at the same time, which with eight specialists is "doable," but "it just doesn't happen." Amy communicated her frustration as she commented [I#3, May 22, 2017]:

> But even then, I thought without being in a team you would think you'd have, you know, the person you work with next door to, or someone in your team that would sit down—but no-one really does that, across the entire school there are very few people who plan with anyone else. Everyone does their own individual planning.

Amy made the point that some people "share their planners," but "everyone does their own individual planning." According to Amy "teams have suggested using their team meetings [but] there's just not enough time. There's so much stuff that comes up that you have to do and talk about, it just doesn't happen." While "co-planning of lessons is the task that has one of the highest likelihoods of making a marked positive difference on student learning" (Hattie, 2012, p. 66), from this evidence it would appear that collaborative team planning is not valued by the principal, leadership or the teachers, therefore structures have not been implemented for this to occur.

Amy emphasized that implementing "collaborative planning [is] one of my … [goals] for next year if I am still in the same role," and suggested that "it would be difficult, but I would want to make sure everyone is on board with it. I would trial it for a year and be able to feedback to the staff how it went and what were the benefits." Amy pointed out that she believed if teachers "have a PLT that [is] not working all that well, or isn't that collaborative, then they probably don't think it's going to work that well, or they don't see the value in it." According to Amy while each School Mathematics Leaders at the school supported individual teachers with planning as part of their role, there was no consistency of approach. Amy also made the point that "student outcomes [in mathematics] as a whole haven't changed." Judging from this evidence, if "team planning has the potential to support teachers in their mathematics teaching" (Davidson, 2016, p. 187) it could be speculated that collaborative planning would be a positive step to take. Teachers planning together is very important (Gaffney, Faragher, et al., 2014). Amy mentioned that she had approached a team leader to gain her support and commitment to trialling collaborative planning, but it had not eventuated.

5.3.1.2 Supporting professional learning teams.

5.3.1.2.1 Moderation.

Meeting in professional learning teams was part of the practice at Amy's school. According to Amy they were held every two weeks, with mathematics moderation once a term. Although Amy did not run these meetings, she attended and supported teachers in the team. The moderation meeting observed began with four Year 3/4 teachers from professional learning team (PLT) 4 and Amy as one of the School Mathematics Leaders. The purpose of the meeting was to discuss student responses to an assessment task. The team leader began the meeting by reading a moderation agreement [V#1, 2:09 – 2:44]:

> **Team Leader:** In PLT 4 we believe the purpose of moderation is to come up with a shared understanding of expectations through professional discussions.
>
> **Amy:** Agreed?
>
> **Teacher 2:** Yes. [No-one else commented]
>
> **Team Leader:** Considering we're using shared expectations already established, it's just the professional discussions. [Laughter from the team leader, Amy and Teacher 2. Teacher 1 and Teacher 3 did not react or speak.]

The reading of this agreement by the team leader validated the comment Amy made at an interview [I#1, October 25, 2016] before the meeting, suggesting that possible tension existed between members of the team. "Teams are more effective when they have clarified expectations regarding how they will work together" (DuFour & Marzano, 2011, p. 76). However, from the video evidence of the meeting I would question if the team had actually translated these expectations into a commitment. This agreement emphasised the point of the necessity for professional conversations. Amy communicated at an interview [I#3, May 22, 2017] that some of the discussions that occurred previously between mentors and teachers had “not been very professional.” Interestingly, Amy explained that the team goal at that time was focused on professional conversations and “leading discussions in moderation sessions, with the thinking that we need to keep them respectful, allow everyone to have their say, and challenge others thinking.” Evidence of this tension was obvious when the discussion became slightly heated and relationships were strained.

5.3.1.2.2 Discussion of assessment task.

While I continued to observe this moderation meeting with the Year 3/4 team, I noticed as the meeting was about to begin, Amy described a mathematics task that she had recently seen to the three other teachers in attendance. The team leader arrived late and began searching on her laptop for what turned out to be the team agreement, to read before the Year 3/4 team began the moderation, which was referred to previously. Without any formal comment to indicate the meeting had begun, video evidence [V#1, 00:25 - 00:41] showed Teacher 3 interrupted with the comment:

> My high. I’ve left my assessment book, so I don’t have all the scores, but my high kids didn’t do very well in that first question and I wonder if it’s because we haven’t done arrays because of our maths goal. We’ve been focusing on the higher stuff with the high kids, that we’ve left the lower array questions.

The Year 3/4 team had used Packing Pots from the *Scaffolding Numeracy in the Middle Years* Assessment Materials for Multiplicative Thinking booklet (DET, 2008) as a summative assessment task. Although in the interview, Amy shared that teachers do not plan together, there must have been some consistent planning or discussion between teachers in this team, if Teacher 3 felt that arrays had not been a focus during their work on multiplication and division.

It was obvious from the beginning of the meeting that Teacher 3 was anxious about her students’ performance on this assessment task. Teacher 3s anxiety was reflected in the number of comments and questions she made during the moderation meeting. There were several occasions when Teacher 3 mentioned that she did not understand, such as in her comment, “well you said this isn’t correct, but why is that not correct if his circles are almost, you can’t expect him to be drawing one hundred per cent accurate” [V#1, 3:34].

Teacher 3 added indicating her uncertainty, “I find it weird that they are wrong” [V#1, 5:27]. At another stage during the discussion, [V#1, 42:59] Teacher 3 obviously needed further clarification, as she asked, “so what does this mean then? I’m not quite getting the link between what we are doing. Like what we’ve just done and now what we are doing.”

Other members of the team, including Amy as one of the School Mathematics Leaders, appeared to understand and attempted to explain elements of the assessment that were confusing to Teacher 3, as can be seen in the transcript below. Teacher 3 was particularly tense, and although the other teachers appeared to calmly clarify her concerns, there were several occasions that indicated frustration, particularly by the team leader and Teacher 2. For example [V#1, 03:44 - 5:04]:

Teacher 1: But the answer is 28 and the [actual] answer is 24

Team Leader: Because it’s 6 x 4

Teacher 3: Yeah but

Amy: He’s done 7 x 4

Teacher 2: That’s just the array though, but you have got to look at the question.

Team Leader: So, he should get one point because he’s actually tried to work it out as an array and it says attempted to draw pots in an array, but it’s incorrect.

Teacher 2: [Forcefully states] In an array but it’s the wrong answer!

Teacher 3: But why is it incorrect?

Teacher 2: Here [points to the scoring rubric] Incorrect because it’s not equal that.

Team Leader: It’s incorrect because the answer is

Teacher 2: [Interrupts] 24

Teacher 3: But only because this circle drawn like that six times

Team Leader: But he’s actually overlapped here [points to work sample] so he hasn’t drawn it.

Teacher 2: No

Teacher 3: Okay

Amy: Measurement wise does it actually work out that way? Like if they had a ruler. Does that make sense? [This comment was completely ignored by all team members and the discussion went on.]

Teacher 3: But see this person has done the correct answer but hasn't drawn his circles correctly. He hasn't done it tightly packed, so then is his correct?

Team Leader: I understand where you are coming from, but ultimately the answer is wrong, because the answer is wrong because it's 24, because that's what it's calculated as.

Amy: I can see your point too.

Teacher 2: [Holding up an example] Yes

Team Leader: Because the circles have slightly changed whether or not they use a finger or a pencil or whatever it is, because I've got some who did exactly the same but different sizes. I had

Teacher 2: [Teacher 2 interrupts assertively, holds up an example and points to it indicating drawn pots] But even if I roughly drew them it should

Team Leader: [Interrupts] Comes out the same and I have got. I have got kids who did exactly the same as what he's done which is 7 by 4, exactly the same thing. The thing is it's wrong, because it's 6 by 4.

5.3.1.2.3 Rescuing teacher 3.

This discussion continued and just when I thought the teachers were about to move onto the next question, Amy re-opened the discussion, pointed to the assessment task [6:33] and said directly to Teacher 3, especially because it says, "into the tray as tightly as possible." [Amy points to the instructions and smiles broadly.] Then Teacher 3 puts her hands out and shrugs and says, "to me that's still not right" [V#1, 6:37] indicating that she still did not see her student's response as incorrect, when it clearly was.

This video evidence [V#1] supported the notion that there was tension between the Year 3/4 team members. It was also apparent in the video evidence that Amy, as one of the School Mathematics Leaders, continually attempted to rescue Teacher 3 with comments such as “measurement wise does it actually work out that way?” [V#1, 4:14] and “I see your point” [V#1, 4:33]. Amy added further comments throughout the meeting which indicated that she appeared to be attempting to rescue and reassure Teacher 3, such as “so for a low [achieving student] that’s good that she got an answer” [V#1, 45:42]. On another occasion, as the team discussed whether a student from Teacher 3’s grade had recorded a correct or incorrect response, Amy tried to justify an incorrect response with this comment, “but logically if there was already one” [V#1, 8:17] [referring to one pot in the tray already illustrated]. Then she appeared to be encouraging Teacher 3 when looking at a student work sample with this comment, “this is good” [V#1, 10:50] [points to a work sample where a student had used an interesting strategy to solve the problem] and said, “That’s fantastic” [V#1, 11:00].

The following example further illustrates examples of how Amy appeared to provide encouraging comments or rescue Teacher 3, and also demonstrates some of the anxiety exhibited by Teacher 3 in relation to her students’ performance in this assessment [V#1, 18:23 - 18:47]:

Teacher 3: He’s like in grade 5 maths level.

Teacher 1: So maybe it is a 1.

Amy: I’d give that a point.

Teacher 1: He needs to work on arrays though. Look at his circles. [laughs]

Teacher 3: Ok, that’s what I’m saying because we have been doing the maths goals at their high level, we haven’t done the low stuff with them, but I’ve kind of done them a disservice.

Teacher 1: But I guess that you would think that

Teacher 2: [Speaks over] You assume that they’ve got that.

Teacher 1: Well, they’ve been doing arrays since grade prep and one.

Amy: You would assume. I’m fairly confident that he could make a pretty good-looking array but it’s this that’s thrown him [as she indicates an array with her hands and then points to the assessment task].

In the video, I noticed all three Year 3/4 teachers in the meeting, at some stage clarify points that Teacher 3 questioned and appeared to not understand. Amy, who sat beside Teacher 3, continued to discuss various aspects about the student work samples, and also added reassuring comments and looks to her throughout the meeting. Video evidence [V#1, 22:52] showed at one stage, when Amy was in deep discussion with Teacher 3, neither of them was aware that the other team members were addressing questions to Teacher 3 and watching and waiting for them to re-join the moderation discussion. Teacher 1 suggested they move on to question C and asked if anyone had questions [V#1, 23:00]. When there was no response, Teacher 2 asked Teacher 3 specifically by name if she had any questions [V#1, 23:06]. Teacher 3 did not respond and kept talking to Amy about her students' work. The other teachers all sat quietly appearing annoyed while Amy and Teacher 3 continued their in-depth discussion. The team leader looked across, and after 24 seconds [V#1, 23:30] interrupted the conversation and said, "sorry ladies could we move on to C? Do you have any questions?" If, as Amy said, the focus of the mentor program was on teacher development, Teacher 3's mathematical pedagogical content knowledge was a concern.

Studies have emphasized "the importance of shared experiences and discourse around texts and data about student learning and a necessity for shared decisions" (Bransford et al., 2000, p. 198, 199) during teacher collaborations, which was evident as part of the moderation process. The following transcript provided further evidence of the discussion of student data at the moderation meeting [V#1, 8:37 - 10:08], the teachers interpretations of the assessment and how Teacher 3 continued to struggle with gaining a deeper knowledge of her students' mathematical thinking (Kazemi & Franke, 2004):

Teacher 3: If he had written 24 take-away 1 yeah, I could have given him a mark I suppose.

Amy: Yeah

Teacher 3: If he'd actually written 24 take-away 1. He's written 4 by 6 and 6 by 4 so I so want to give it to him because I know

Amy: Yeah, I know

Teacher 2: But it doesn't actually say 24 on there anywhere at all

Teacher 3: No that's what I'm saying**,** that's what I'm saying. I wanted him to put 24. He'll only get one.

Amy: Yeah, but I suppose you being able to give him one mark instead of two doesn't really change a lot. You know that [he's capable].

Teacher 2: [Interrupts] No. It's about being able to see how he thinks and how he is working.

Teacher 3: He'll only get one for each question.

Team Leader: This isn't a measure of everything that they are able to do.

Amy: No. That's right.

Teacher 3: No. That's what I'm saying.

Team Leader: It's just a snapshot of a whole lot of things.

Teacher 3: No. This whole test doesn't show me where they are at academically at all. Like it won't count towards …

Team Leader: But moderation is just about, like the grade ones are only doing subtraction and they are only doing one CAT [common assessment task] on subtraction. That's it. Everybody is only doing one area.

Teacher 3: Yeah, but this isn't going to inform my results, my reports.

Teacher 1: It does show you something.

Teacher 2: It does. It shows you their thinking, their working out.

Teacher 3: Yeah, but this isn't going to inform my report writing.

Team leader: But you don't put your, see I will include this.

Teacher 2: [Interrupts] Your report writing isn't based on one piece of work though.

Team Leader: But I won't only use this. I've got a whole lot of other things to measure their multiplication and division. I've looked at it compared to where they were last time. So, what's their thinking? What are the strategies they are able to use? When they can actually …

Teacher 2: Yeah. That's what I've done.

Teacher 3: So why didn't we just use the Butterfly Test again then? Wouldn't that have been better to show, because we normally do before and after tests? We do the same tests.

Team Leader: Because people have actually used those and actually taught to that test. Then kids might remember how to do it, but when they approach a similar situation in a different context

Teacher 2: That's right.

Amy: And they should be able to if they have learnt …

Teacher 2: Be able to apply it.

Team Leader: In a different context but same problem-solving skills. They might not actually be able to apply it. They can apply it to that, because that is what they have learnt, because that's teaching to the test.

Then later in the meeting another example: [V#1, 36:07 - 37:11]

Teacher 3: That's what I am saying. These tests don't truly reflect my kids.

Teacher 2: But, but

Team Leader: So, base it just on the test them. So, your threes though

Teacher 3: That's what I'm saying. [Speaks at the same time as Teacher 2]

Teacher 2: [Says forcefully] Why are you saying it doesn't truly reflect your kids? Why are you saying that?

Teacher 3: Because that's what the team leader

Amy: Because she thought her high ones would have been higher. [Teacher 3 and Amy speak at the same time].

Team Leader: [Interrupts and speaks on behalf of Teacher 3] No. No. Because she's saying that she has got kids that she believes that are performing above level that only got three points which means they are at grade 4, not above.

Teacher 2: That got less than three? So, three is at level. So, this is only one piece of work though you need to remember. It's reflective of what they could do on that day.

Team Leader: So, base it on the test. Pick one.

Teacher 3: So that is what I'm saying.

Amy: And it means maybe that.

Teacher 3: Right now, though, we're moderating what they did on this test.

[All teachers spoke at the same time]

Teacher 1: That's right.

Teacher 2: That's right. Yes

Team Leader: And also, this [points to shared understandings document.]

Amy: Yeah, but it also means that if your higher kids, the ones that you've got at above [Year level]

Teacher 3: [Interrupts] We shouldn't be thinking about them in the classroom though.

Teacher 2: No

Teacher 3: We're basing it on this test.

Teacher 2: Yeah. So, that's right.

Teacher 1: That's right.

Team Leader: Yes

Teacher 2: It's only what you've got here as evidence that they've done on this day.

> **Amy:** But some of your kids who are above if they didn't do well in these, maybe that's their area they still need to work on. In terms of being above, multiplication and division is not their [stressed this] strongest point because it's only [one domain of mathematics]. That's what we are looking at, multiplication and division in the entire thing.

Again, Amy attempted to clarify a point and rescue Teacher 3. It was interesting to note the number of responses by members of the team during the moderation meeting. Although all team members regularly contributed to the discussion, Teacher 3 spoke most often. Teacher 3 frequently questioned what was happening and often sought clarification on aspects being discussed. The team leader spoke on 208 occasions, Teacher 1 spoke 210 times, Teacher 2 spoke 181 occasions, Teacher 3 spoke 221 times and Amy spoke on 184 occasions during a 59 minute and 22 second meeting.

5.3.1.2.4 Leadership practice.

The moderation meeting described above was facilitated and run by the Year 3/4 team leader, with Amy as a support, and three other teachers in attendance, Teacher 1 and Teacher 2 came to the meeting very well prepared with their assessment scored and highlighted on the rubrics. The team leader explained at the beginning of the meeting [V#1, 3:13] that she had worked out percentages to see if her students' results had improved. However, throughout the meeting she appeared to be engaged in continually assessing and adjusting her students' scores. Consequently, I noticed several periods of silence from the team leader, who at times, other than reading the team protocol did not appear to be making any attempt to lead the meeting. Video evidence showed on at least eight occasions Teacher 1 and Teacher 2 made suggestions that would appear they were leading the meeting, such as:

> **Teacher 1:** [02:59] Do you want to go through the marking guide?

> **Teacher 1:** [03:30] So the first question you had a question about Teacher 3?

> **Teacher 1:** [11:26] So are we all clear on the first one?

> **Teacher 2:** [19:06] So should we look at the next question then? So, everyone is happy with question 2?

Teacher 2: [19:27] Yeah. If they've used repeated addition, skip count that sort of thing goes to 1 point.

Anyone have any questions about that? No

Teacher 1: [22:00] So question 3 then, if we are happy with that one.

Teacher 1: [23:00] So C. Does anyone have any questions? [Looks across at Teacher 3]

Teacher 2: [23:06] Do you have any questions Teacher 3?

The moderation process should involve spreading out student work samples, making copies of student work available for all team members to see, so they can engage in respectful discussion to develop a common understanding of achievement levels and assessment criteria (Ontario Ministry of Education, 2007). Interestingly, this did not occur during this particular moderation meeting. During my observation, each teacher held their own student's assessment tasks and only showed those work samples that they had questions about or felt were interesting. This approach to moderation appeared strained, and at times teachers in the team had difficulty being able to see some of the samples being discussed. On several occasions, the discussion was only with the person sitting next to the specific teacher.

At one stage, at exactly [V#1, 27:54] as Amy and Teacher 2, who sat next to each other, discussed several student work samples, the team leader appeared annoyed and asked, "could we actually all have a look because everyone in the team is doing the discussion?" However, previous to this, [V#1, 22:52 - 23:30] the team leader did exactly the same thing with Teacher 1 and did not share work samples or include others in the discussion. "The most powerful aspect of teacher moderation is the discussion involved in assessing student work and the collective sharing of effective strategies in planning the next steps for instruction" (Ontario Ministry of Education, 2007, p. 1). If teachers cannot see work samples, this must distract from the discussion and the learning, and the ability to work through "a collaborative and collective effort" (DuFour et al., 2010, p. 14) to inform professional practice. From the video evidence, if Amy wanted to encourage a more collaborative effort this would have been an opportunity for her to encourage the sharing of work samples. However, it would seem as though Amy's hands were tied as she was not leading the meeting and her relationship with the team leader was already strained.

5.3.2 Mathematics leadership challenges experienced by Amy.

5.3.2.1 Mentoring teachers.

Although Amy believed working as a team of School Mathematics Leaders was an advantage, she also mentioned there were "some issues in terms of stepping on toes." Amy believed one of the biggest challenges experienced by the School Mathematics Leaders when supporting teachers in mathematics at her school, was "the mindset of people in the team, or maybe their insecurities with their own beliefs on how they are seen, or if they are an expert really in their area." Amy pointed out at the time of the interview [I#1, October 25, 2016], that although "we have our set people we work with," some leaders had been approached by teachers they do not normally work with, who wanted help. Amy claimed that she didn't "have a problem with this personally," and said, "I think the people I mentor, I'm happy for them to go and touch base with whoever they want." She stated, "if [teachers] are at a point where they're finding their own PD, and they're leading their own learning … and going, right, I want you to come in and work with this, … how fantastic is that?" Amy explained that teachers she did not mentor had approached her, which she stated had "been a nice feeling." As a result, she adapted her time to work with more teachers for "smaller pockets of time."

According to Amy teachers preferred to choose the School Mathematics Leader that they would like to work with, but this had caused some issues. Amy commented that, "when we first started this program, we worked with PLTs. So, I worked with PLT 5, [and] I mentored everyone in that team." Although she explained, "there were difficulties with that, which is why we went to individuals, and we felt that was better meeting individual needs." According to Amy [V#2, 5:45 – 6:30]:

> Originally, I worked with what are now the sixes. I started working with them as grade threes as a cohort. I worked with them in four as a cohort. So, every teacher in that cohort and then worked with that PLT. Then we just took on feedback from the teachers who said sometimes they weren't getting the mentor that they wanted, or if they were changing year levels, they would end up with the same mentor each year, whereas they wanted a change. So, it was based on their feedback. We still think it worked better [the original] way. You are more connected to the PLT that way. I work with two people out of the six, but not the leader, and I do find there's a difference there, because I'm not connected to her makes it harder, I think.

In a prompted written reflection [WR#1, A], Amy emphasised this point further when she described "not feeling well utilized by my team leader (Year 3/4, PLT 4) this year. In comparison to previous years, I feel like I have done nothing." She wrote, "considering their team goal is to improve student outcomes in multiplication and division, I feel l could have done a lot more. I have offered a lot, but very few times have I been taken up on the offer." Amy also described this as "an ongoing issue." Based on this evidence it suggests change to the structure of the program or the way the support is provided would be an advantage. It could also be inferred, that one of the reasons for inconsistencies in results could be because the School Mathematics Leaders only worked with some of the team, as in Amy's case, and not always the team leader.

The decision to match individual needs with School Mathematics Leaders obviously made a difference, and as Amy pointed out, she did not feel connected to the team leader which made it more difficult in her support role when she attended the meetings. Amy commented [I#3, May 25, 2017]:

> How different might it have been had I been able to mentor each one as well as seeing them collectively as a group. So, I wonder whether that would have a bigger impact. I mean, now they've [Leadership] sort of taken it to another level [in literacy]. I think they realised how much of an impact having a team goal – even the teams were amazed … And I was like "see how much impact you can have with everyone together." Like throwing ideas around and everything.

This could also have contributed to tension in the relationship between Amy and the Year 3/4 team leader, which was obvious with the above comment, and noticeable during the meeting observation. However, according to Amy "the teachers will still tell you they prefer the individual approach to having a mentor. They would like to be able to pick and so we have stuck with that" [V#2, 6:32 - 6:38].

5.3.2.2 Role clarity.

Amy commented in an interview [I#3, May 25, 2017], when the team of School Mathematics Leaders began in their mentor role, "I think we struggled at the start, like not having role clarity, as everyone does, we just want to be told what you want us to do, and we'll do it." She explained, "we were doing the program [and] they just sort of let us go. We had free rein, which was great, but then the lack of guidance maybe, you know is quite difficult." This sentiment is echoed in the literature when Millett and Johnson (2000) described the struggle of School Mathematics Leaders not "having clarity of vision about priorities for action and ways of working" (p. 401). Tension can occur if the support to carry out the role is not recognised (Millett, 1998). The evidence showed that while resourcing the role was a high priority at Amy's school, there appeared to be lack of "coherence and consistency within the school environment" (Millett & Johnson, 2000, p. 401).

In the beginning, there was also some tension when working with teachers. Amy commented [I#3, May 25, 2017]:

> Being seen in the school as – so if we came up with an idea of how we wanted to change maths in the school, when you were working with teachers, it was almost like a suggestion. It didn't come from leadership, so some people were like, "Oh, that's a lovely idea, but nah, I'm just going to keep doing it my way." So, they were lovely about it, but we realised we need to have people on board.

If teachers "cannot be persuaded that a new approach is valuable and be certain of support if they implement it, teachers are unlikely to adopt it - at least, not without strong accountability pressures to do so" (Timperley, 2010, p. 7). Based on the evidence, this appeared to be the case at Amy's school. According to Amy, the focus changed once the mentor program was included as part of the Annual Implementation Plan (AIP), because it "was basically achieving one of the AIP goals." Amy also pointed out, "to begin we weren't working with leadership … [but] it made a big difference when we started working with them and we met with them every week."

Amy revealed that, "we also struggled with the concept of where we sit as leaders. We still do sometimes … I think we're considered middle leaders." Having role clarity would have contributed to teachers, as well as the School Mathematics Leaders themselves, being aware of what was expected of them. According to Grootenboer et al., (2015) middle leaders have the "greatest capacity to bring about positive practical and sustainable change" (p. 217) by exercising "their leading in and around classrooms" (p. 277). As these School Mathematics Leaders worked in and around classrooms and worked closely with leadership, potentially they had the ability to bring about positive change in teachers' practice.

5.3.2.3 Team leaders pedagogical content knowledge.

The evidence showed there was a need to support teachers to build their MCK and PCK, but it was obvious that some of the Year level team leaders also needed the same support for knowledge-building from School Mathematics Leaders. While I noticed Teacher 1 and Teacher 2 discussed the assessment task during moderation and demonstrated their MCK and PCK in the comments they made, on several occasions I questioned the mathematical content knowledge of the team leader. Evidence can be seen in the team leaders comment below [V#1, 47:12 - 48:43]:

Team Leader: But multiplication isn't covered in level two, is it?

[Teacher 1, Teacher 2 and Amy all talk at the same time]

Amy: Uh um. It talks about. They won't use the word multiplication

Teacher 1: Yeah, because these ones are basically the same

Teacher 2: Yeah, it is. Repeated addition and skip counting and those things

Amy: I'm doing it with grade two at the moment

Teacher 2: and groups of

Teacher 1: The thing is this is mostly with 2s, 3s, 5s and 10s

Team Leader: [Searches for a document on her laptop and then reads out] [48:12] Ok use multiplication through problem solving. Three groups of four books equals twelve books. Can show multiplication through groups and commutativity. I hate that word. Three groups of four equals twelve and four groups, so the fact families. Division can share equal groups. Partition example three equal groups. Quotation three groups of three [frowns]. That is what they have got written here.

When the video evidence was analysed, it became obvious that the team leader was unsure of the expectations of teaching multiplication in Year 2. It was also obvious that the team leader did not associate the terms quotition and partition with division, judging from the way she mispronounced the term quotition and the frown on her face.

5.3.2.4 Leadership style.

As was mentioned earlier, the evidence showed that Amy had not yet developed a strong working relationship with the Year 3/4 team leader. Some trepidation was obvious from the tentative contributions that Amy made during the PLT meeting and on at least one occasion from Amy's response [V#1, 23:30] when the team leader needed to interrupt a discussion, she was having with Teacher 3. Although Amy continuously contributed to the moderation discussion, I noticed that she was not as confident working with this team as she was with the Year 5 team during a second observation. Amy contributed the second least number of responses of the group. However, this could be indicative of Amy's leadership style. Amy often spent "time getting people's ideas and buy-in" and "building trust, respect and commitment" (Goleman, 2000, p. 10) with teachers she worked with on a weekly basis. Collecting feedback on the mentor program from teacher surveys was evidence of a democratic leadership style. Amy also demonstrated aspects of an affiliative leadership style as she attempted to build relationships, create harmony and showed empathy towards teachers in the Year 3/4 team. Effective leaders are constantly working on building relationships (Fullan, 2020).

5.3.3 Success in leading mathematics: Amy.

5.3.3.1 Working on a team goal.

Amy pointed out, "I don't feel like I'm the maths leader, like there's a team of us, which is good and bad. It is good in the sense that we're all working together hopefully on the same goal," which Amy explained "at the moment, led by leadership it has been developing our shared expectations [in mathematics], which came out in our survey" as something "the staff really value." It was "the one thing [teachers] think is developing consistency across the school." According to Amy, "as a school we have been so inconsistent with everything." She pointed out that "we need to do something as a school," because at the moment "teachers here sort of just do what they want." Amy suggested [V#2, 17:26 – 17:39]:

> This is a big win for us in terms of developing some consistency across the school. For us this is amazing, because we don't follow programs as a school as a whole. Even [in] literacy … it's not something we do as a school.

This would indicate that some positive changes had occurred with a new principal and something Amy believed was really important.

5.3.3.2 Professional learning.

Continued professional learning was valued at Amy's school. This included several external professional learning opportunities as well as the *Primary Mathematics Specialist* (DET, 2017a) training and the Bastow Leading Numeracy (DEECD, 2014) course. Also, as part of their leadership role Amy explained that each School Mathematics Leader met once a week with the school leadership team and alternate weeks with the assistant principal to develop their professional practice [V#2, 3:15 – 3:26]:

> We do have two hours a week where we meet with leadership. So, two hours out of my three days, which I think is quite significant, but to make sure that we're connected and all on the same page. They're providing for our learning as well as us providing learning for the school.

Based on this evidence it was apparent that the School Mathematics Leaders, had undertaken a wide range of professional learning which supported them in their work with teachers in the school.

While Amy experienced many challenges and some successes in her School Mathematics Leader role the following points that include principal support and Amy's reflections could be described as both.

5.3.4 Successes and challenges: Amy.

5.3.4.1 Principal support.

In an interview [I#1, October 25, 2016] Amy pointed out that her school principal was "very supportive of the [mentor] program." Although "it's a big expense," she said, "he sees it from a different perspective," and saw "what the program does for the teachers in the school" and "he really values this program." Amy believed the leadership in the school "definitely sees the benefit, and that is why her principal and the leadership team want to try and make it continue if they can." However, Amy believed that the program in its present form "needs to be changed." According to Amy the program "was going great guns until recently." She explained, "I think it was because it stayed the same. We haven't adapted with the needs of the school or the students, but I think this is where changes are going to be made." She also mentioned that there was pressure from parents on School Council who were concerned with "our NAPLAN data, which is quite poor, saying … isn't the mentor program supposed to be helping with that and why not?" According to Amy the

School Council felt “we are spending too much money on it and it’s not having an impact,” and with a change of principal in the coming year, this support was likely to change.

5.3.4.2 Reflecting on the School Mathematics Leader role

In the same interview [I#1, October 25, 2016] Amy pointed out that despite some “individual successes, … student outcomes as a whole haven’t changed” over the term of the program. Amy explained, the mentor program “has been focused on teacher development not student outcomes,” but she believed “there was the idea that through building teacher capacity that would then lead into student outcomes, and … it hasn’t happened.” She also stated, “I feel like our maths is getting worse, and I’ve be in this role for five years. So, what impact have we had? I walk out of classrooms and I’m a bit like, how has this happened?”

With the mentor program in its fifth-year, teachers at Amy’s school were asked to complete a survey to obtain feedback on the program. Amy suggested, “it’s time to start listening to what staff are saying and making changes accordingly.” Amy said it was also a “where to next? for us.” Teachers were asked to respond to, “whether the mentor program was providing for their professional development, whether it had changed their teaching practice, and whether it was having an effect on student learning and student outcomes” [V#2, 21:53 - 21:01]. Amy argued that “there were a couple of responses that would completely disagree with that, but for the most part, people still think it is changing their practice” [V#2, 21:02 - 21:07].

According to Amy, “this kind of data showed they [teachers] still really did want it to some capacity” [V#2, 21:15 - 21:17] and teachers “really do value it” [V#2, 21:17 - 21:18]. However, it would appear that the way it was organised caused tension among some staff, and according to Amy “some stepping-on-toes.” This was also evident in a prompted written reflection response [WR#1, A], communicated by Amy to the question that was part of an in-school survey: Does your PLT use their mentor well? Although the responses were anonymous, Amy believed a member of her PLT possibly wrote this about her. “I think our mentor has a lot to offer. I’m not sure why we don’t [use our mentor well]. I think our [team] leader may like to have control over our meetings.” A further response she mentioned and believed was from another member of her PLT team was, “I’m not sure how we could have used our mentor better, but I don’t feel that we have. I’d love to hear how other teams use their team mentors!” Reflecting on these comments, Amy wrote [WR#1, A]:

> I think this also means we (the school mentors) need to look at how we work with PLTs. At the moment, we go to every second meeting, but I know for me this isn't working and I certainly don't feel as connected. We have also noted in the past that there seems to be a better connection to the team when the mentor is actually mentoring the leader.

Amy also commented, "I've been saying the program needs to be changed for a while now anyway" [I#1, May 25, 2017] and:

> We always knew it couldn't continue forever, but I'm not sure that they can cut it from three to nothing… There are some people - and you're always going to have graduates - a couple of people in the school now who would not cope without a mentor.

Although graduates in the school have a mentor, Amy pointed out, "it's not where I always see the greatest need." Interestingly she revealed that "there are teachers in the school who don't have a mentor at all" but Amy believed that the role was still needed and mentioned that she would "be pushing that to leadership at the end of the year."

Although Amy said, "the idea is we want to eventually do ourselves out of a job," [V#2, 20:39 - 20:40] the evidence showed on several occasions she had approached leadership with ideas of how this role could continue. Amy admitted, "it's time for a change," but stressed the point, "you can't not have someone having that focus." She stated, "something's not working, but I need to figure out what it is and how to change it." Amy went on further to say, "I don't have a solution yet, but you can't just leave it." It's possible to discern from these comments that Amy was eager for her mathematics leadership role to continue and that she valued the opportunity to work with teachers at her school. However, realistically she believed it was possible her role would be discontinued. Thinking about where to next with her role, Amy made the point, with the appointment of a new principal "we're … starting to get that consistency" and some "stability" which "is making a difference," although as Amy pointed out with added pressures from School Council this could mean an end to the program.

Looking at the year ahead Amy spoke about the possibility of working "fulltime back in the classroom with maybe a few extra hours" for mathematics leadership responsibilities. Should her School Mathematics Leader role change, Amy commented “what can you actually achieve on top of what is almost a fulltime classroom role, which is your main priority, what can you realistically achieve at all?”

5.3.5 Building professional learning communities: Amy.

Research shows the importance of teacher collaboration in learning communities (Bransford et al., 2000, DuFour et al., 2010, Fullan, 2001). Although teachers at Amy’s school did not plan collaboratively as a team, they met together weekly in professional learning communities and the School Mathematics Leaders attended as a support. The School Mathematics Leaders attended professional learning team meetings “on a fortnightly basis and provide[d] professional learning based on the needs of the team members and the cohort of students.” According to Amy professional learning included “the implementation of common assessment tasks (CATs), how to use Mathematics Online Interview (MOI) data, how to analyse your OnDemand data [and] maths games for tuning in.” In a school document [A#I, A] provided by Amy it was mentioned that teachers:

> Find this time beneficial for discussing the different groups of students and how we can best cater for all their needs. This time is useful for sharing ideas, lessons and resources we have tried, discuss how they went and talk about where to next.

However, as Amy explained, some professional learning teams were focused more on teaching and learning than others. Amy suggested that professional learning team meetings in the upper school [V#2, 4:29 - 5:03]:

> Are very “adminny” still, in the seniors, they struggle to find the time to make it more about teaching and learning. We are trying to, and I think [it is] helping [having] the whole school working on moderation and things like this. We are all doing it, whereas in the juniors I know the mentors I work with that are working with the juniors are there every second week working on teaching and learning, whereas mine, it’s probably not every second week. I’ll be there, but it might not still be focused on anything I can help them with. But that’s OK.

During an interview [I#3, May 22, 2017], Amy suggested that there are some teams “that can barely stand to be in the same room together for a PLT meeting” and others who “really challenge each other.” She also commented “I don’t know how collaborative you would call our teams.” In relation to the Year 3/4 team in the interview [I#3, May 22, 2017], Amy commented:

> There are clearly some personality issues within this team, and you can almost tell by the way they sit at tables. Everything looks nice on the surface, but last night there were comments and cutting people off as they were talking and things like that. It's interesting.

Supporting teachers to learn during professional learning team meetings was difficult in some teams at this school. Even as teachers moderated mathematics once a term, Amy explained, "unless it's a forced like you're told you have to fit in moderation, … it's very adminny and so it's not really about collaborative planning." However, according to Amy, many "teams struggle to find the time to make it more about teaching and learning," but the recent addition of team goals as a focus, have made a difference.

Teachers working with each other are a necessary condition for improving practice (Fullan, 1993). However, it could be inferred from this evidence that "organizational elements required to develop shared purpose and principles of practice" (Gaffney, Bezzina,et al., 2014, p. 91) were not fully in place in Amy's school. The very essence of a principal's "job is to create the conditions in which a PLC will flourish" (DuFour, DuFour, Eaker & Many, 2010, p. 257). A possible reason for the lack of focus at this time, could have been because Amy's principal was on leave, and the remaining members of the school leadership team, according to Amy [I#1, October 25, 2016], were feeling overwhelmed with "so much on their plate."

During an interview [I#1, October 25, 2016] Amy emphasised her frustration when she explained that over the last five years "student outcomes as a whole haven't changed." She also expressed her concern in the comment "I feel like we are failing our kids." Amy was also concerned about a lack of consistency in programs across the school and attempted to think of some solutions. One of her solutions was "to work with one of the teams" and plan collaboratively. However, "meaningful collaborative work is more likely to flourish when the foundational conditions are in place" (Fullan & Quinn, 2016, p. 64) and at that stage, with her principal on extended leave and teachers who did not "feel like giving up an hour APT," Amy expressed her frustration. Amy found, it difficult to get a team to commit and it appeared that leadership felt it was "too hard to organize." Based on this evidence it could be inferred that "until members "do" differently, there is no reason to anticipate different results" (DuFour et al., 2010, p. 12).

In summary, the evidence showed that Amy supported teachers professional learning on an individual basis in the classroom, during planning and professional learning team meetings and on a school wide basis in a variety of ways. Despite the more recent challenges described by Amy, and the struggle she experienced as she attempted to encourage a collaborative learning community, her work in supporting teachers to learn was valued by teachers and the principal. Developing a community of practice requires members who can engage with one another (Wenger, 1998) and in the case of some of the teachers at Amy's school a community of practice was still developing.

5.4 Case Study 4: Robyn

Robyn worked in an established school, with an enrolment of approximately 430 students located in a bay side suburb in the south-east of Melbourne in Victoria. As a School Mathematics Leader for the past five years, Robyn had been involved with many projects as part of her mathematics leadership role and led a team of teachers from Year levels across the school in a mathematics professional learning team. For the majority of this time Robyn was also the Year 3/4 team leader and a full-time classroom teacher with no allocated time release for the implementation of her mathematics leadership role. During 2016, Robyn reduced her time fraction to three days a week and continued to lead her Year 3/4 area team and mathematics. At this time, she was given one day time release from her classroom responsibilities to take a mathematics intervention group, to mentor a graduate teacher in her Year level team, to plan with her teaching partner and to complete organisational tasks related to her leadership roles.

Robyn appeared quietly confident, had a strong MCK and PCK and was dedicated to leading mathematics in her school. At the initial meeting, Robyn spoke about her love of mathematics and the joy she received from teaching mathematics. Robyn described how she hoped that she could make a difference to the way teachers taught mathematics at her school. Although Robyn had not completed any extra formal training, she had made connections with a university and over several years had been involved in a research project. The research project extended her mathematical knowledge for teaching and contributed towards her understanding of effective mathematics teaching and learning, which she constantly promoted.

Robyn's data revealed ways in which she supported teachers' professional learning. This case study begins with evidence of how Robyn supported individual teachers in their classrooms, with planning and particularly through her work with the mathematics curriculum team during professional learning team meetings. Some of the challenges and successes experienced by Robyn in the role are described together with evidence of how Robyn attempted to build a community of learners and support teachers to learn as she facilitated mathematics professional learning team meetings.

5.4.1 Supporting teachers to learn: Robyn.

5.4.1.1 Leading mathematics.

Robyn was nominated by her principal to lead mathematics in her school and had been a member of the mathematics team for many years before taking on the role of leader. When reflecting on these meetings, Robyn pointed out, “we’d come and talk about stuff every week, every time, and it would be quite negative and we don’t have this and we don’t have that, but there was never any effort to turn anything around.” Robyn believed “there was no push from the maths team to help facilitate [problem solving] or to change our planners or anything. There was nothing curriculum [related discussed] in the maths team.” Robyn explained [I#4, June 7, 2017]:

> In terms of my aims as a leader, I really am hoping to avoid the admin side of stuff, because my experience in maths teams prior to me taking over, … all you ever did was made orders [resources]. I mean we looked at data, yes you have to look at data, but we never made any changes to curriculum, and that’s where I think you’ve got to keep up to date.

Robyn explained, “I felt like we didn’t actually achieve anything” and she “felt like it was a total waste of time.” Based on these comments, it could be assumed that when Robyn was appointed as the School Mathematics Leader, she developed more of a curriculum focus. This focus was obvious during the interviews and observations based on Robyn’s comments and the work on developing assessment tasks completed by the mathematics team.

In an interview [I#3, May 10, 2017] Robyn commented, “I love maths. I love teaching maths. I wasn’t brilliant at maths as a kid, but I thought I was okay.” She went on further to explain what motivated her as a School Mathematics Leader. As a student, “I think I enjoyed it and I worked really hard and … I got satisfaction out of achieving.” And as a teacher she explained:

I love to see that in kids, you know when that lightbulb moment [happens] or when they can articulate their thinking and other kids go “Oh, I get that.” I love that, and you don’t get that giving kids worksheets. All you get is kids that are really quick, and they’ve finished and what do we do now. I want everybody to get on-board with that [teaching rich, open-ended, problem solving tasks] because the kids learn so much.

This comment reflects Robyn’s motivation to influence and support teachers in her school.

5.4.1.2 Supporting mathematics planning.

Although some teachers at Robyn’s school planned together during their time release, there was no formal timetabled collaborative planning time for teams of teachers to meet. The evidence showed that it was difficult for Robyn, as both the School Mathematics Leader and team leader, to support teachers, even those in her Year 3/4 team, to build their mathematical pedagogical content knowledge, when whole year level team planning was not a priority. Robyn explained that she planned with one other teacher in her team, while the other two teachers in her team planned at a different time. Robyn pointed out that [I#1, November 16, 2016]:

The other two teachers sort of plan together, and we both have very different styles. It's been an issue, but that will be addressed for next year, and because we weren't actually having time together, it was really hard to address. So … that was hard.

Robyn also made the point that there is [I#4, June 7, 2017]:

One traditional teacher in my team, I think he thinks his way is the right way, and I think he picks and chooses. He might do some of the lessons that we’ve got on our planner in that style, but I think he's not a true believer. So, I guess that's the challenge. How do you turn those people around? Sometimes I sort of at the back of my mind think, he's not going to be here for much longer. Like, is it worth putting so much effort in? But no, I haven’t given up.

Robyn maintained that she was always willing to share her planning ideas and made them available to others in her team. This suggests that she hoped to influence and build teachers mathematical pedagogical content knowledge based on what she believed was effective mathematics teaching. She commented [I#1, November 16, 2016]:

> All this stuff, I share with the team, it's all on our Google Drive, and it's like, okay we're doing angles, go to the Peter Sullivan stuff. I know there's teachers that still do a lot of other, but I feel like if you start with this gig, you get into the nitty gritty of it, you don't need to be doing work sheets. Anyway, that's just different styles.

As Robyn insinuated with these comments, there were teachers at her school that taught differently from her and were more traditional in their approach. Alternatively, Robyn suggested the advantage of running whole school professional development and demonstrating differentiation using enabling and extending prompts. Robyn explained [I#4, June 7, 2017]:

> If you do it [provide professional development] as a whole staff, and actually do some of the type of activities that I'm trying to get into the planning, and then people go oh yeah, I can see the potential, you know, because I think our biggest stumbling block for a lot of this stuff is you can't give a class one task, and I would argue that you can as long as you've thought it through to scaffold to support the lowies and then to challenge the others. You don't need 100 worksheets.

Although according to Robyn, "some years ago we did improve the planners …" [33:44] she felt that it was time to have another look at them. Planning documents was an item listed on the agenda [A#1, R] for discussion at the mathematics professional learning team meeting, followed by these questions:

> Do they reflect good open-ended activities?
>
> Are we reducing 'paper' tasks?

Robyn pointed out during the meeting [V#2, 28:22 - 28:52]:

> **Robyn:** I don't like our planning documents … I don't know when we can find time to do it …. Ditch the boring stuff that's maybe work sheety and repetitive or from books that we can't even find any more."

It appeared that Robyn believed paper tasks or worksheets were not ideal as opposed to open-ended tasks, despite the fact that some paper tasks can be used effectively in classrooms, depending on what they are and how they are used. It was decided by the mathematics team that a term three goal would be to revise and update planners and link great resources to these.

As the discussion continued, one particular teacher (Teacher 1) discussed how her year level each planned an area of the curriculum and felt that planning together as a team would be ideal. Teacher 1 commented [V#2, 32:01 - 32:33]:

> **Teacher 1:** It's a huge job and it would be great for it to be growing and moving but that means we all have to have our own … in each thing and it's too much to plan. There's too much to plan so that's why we have got it like there's maths and literacy, because otherwise we are all doing everything and then it would be too much. I don't know the answer. I want to have a look at yours [5/6 planner] and see if we can [improve]. What we need is planning for five people at once.

Robyn explained that teachers at her school did not plan in collaborative teams. Judging from this evidence it would seem that Teacher 1 would find it valuable. The video evidence from the professional learning team meeting showed a variety of planning documents that were displayed on the large screen, and comments from the teachers in the mathematics PLT reaffirmed this. The following transcript of a discussion between teachers is indicative of some of the issues when following planning completed by other teachers, which was highlighted in Teacher 1's comment [V#2, 32:53 - 33:38]:

> **Teacher 1:** We use sheets and sheets and sheets …
>
> **Teacher 2:** I think we could do open-ended easily.
>
> **Teacher 1:** Like sometimes you do something, and you just sort of think of something, like the other day.
>
> **Teacher 2:** Like I could do an open-ended easily for my measurement this week. Easily.
>
> **Teacher 1:** Yeah, rather than do.
>
> **Teacher 2:** Rather than have like they're doing rotational activities and doing all that sort of stuff, but I could easily come up with an open-ended. Is that what you would normally have done last year?
>
> **Teacher 1:** That's what I would like.
>
> **Teacher 2:** But we don't introduce it to Foundation? [asks as a question] I'm new to the whole …

Robyn: I think you should open it up. Like you've probably got kids who could use a ruler.

Teacher 2: Oh yeah! Absolutely I have!

Robyn: So how would you know if you're saying use counters to do this?

Teacher 2: No. I do have because I have them on the floor doing it with me.

Robyn: So, open it up, and when you do that put it in the planner because other people don't think like that and we want everybody to have it.

Teacher 1: And that's why you have to have something a bit more. The way ours [planner] is set up

Robyn: Is too prescriptive.

Teacher 1: It's too like lesson 8 and no.

Opportunities such as these discussions in the mathematics PLT and structured opportunities "to share and reflect on each other's practice" are all facets of the change environment that act to afford or constrain teacher growth" (Clarke & Hollingsworth, 2002, p. 955) and cannot be underestimated.

5.4.1.3 Supporting professional learning teams.

Teachers at Robyn's school were allocated to professional learning teams, one of these being mathematics. Robyn explained how this model worked [I#1, November 16, 2016]:

> These people, we've got people from each [year level] area [team] … you know a prep, a one two, I'm three four and a five six. That's always been the team, and they can go back to their areas with anything that we've discussed or anything we want to try, and they will spread it within their area.

According to Robyn, "we have a great culture" and teachers at her school are "all supportive and positive and willing to work hard." She described her views of teachers in the mathematics team [I#1, November 16, 2016]:

> Number one they're willing participants, and sometimes they didn't choose to be on the math's team, so that could potentially cause problems if they wanted to be

somewhere else and they just ended up here. But fortunately, that hasn't been the case. I guess they see a reason for doing what we're doing.

5.4.1.3.1 Developing rich assessment tasks.

The creation and implementation of four whole school rich assessment tasks was a further initiative led by Robyn and supported by her mathematics professional learning team. According to Robyn when she began as a School Mathematics Leader, she felt teachers [I#1, November 16, 2016]:

> Were just doing the same old standardised tests and I think through the cluster meeting again some people started talking about doing rich assessment tasks. Just generally, not as a whole school thing, and someone said, "Well that'd be a really good way to track kids," and I thought, well we don't do that at all for maths. We do lots of stuff for Literacy, running records and TORCH and all that sort of stuff.

Robyn described examples of rich assessment tasks that her mathematics team had previously worked on and suggested, this was still a "work in progress." During the professional learning team meetings observed, the mathematics team continued to discuss and perfect the tasks, decide on suitable diagrams and written prompts to be included and the method of recording and tracking student growth. Robyn said [I#1, November 16, 2016]:

> It has been a work in progress, because there have been glitches with the recording. The first time we did it on Excel, and then it was like how do we transfer that? Where do we store it? Then we decided to do it on Google Drive. So, we set that up, and this is all time-consuming stuff, setting up for the whole school. Then they bought SPA and we were doing our … writing assessments on the SPA program, and then thought, well we really should do the rich assessment tasks on there too … So, we've had three goes at recording.

As the evidence shows, it was challenging to record student results. It was also apparent from observation of three professional learning team meetings that teachers in the mathematics team struggled to decide on suitable diagrams and written prompts for each year level. Robyn continued to work with her teams over three years (2015, 2016, 2017) to adjust and develop these tasks. Robyn pointed out to her team in the first professional learning team meeting observed [V#1, 2:48 - 3:11]:

> I think it's got, like it's got value, but I think its limited value because you know I find, well just with my results with my kids. My kids that are very able don't always show it on these tasks and I'm finding that I guess they are limited to the prompts we give.

Although Robyn said they had moderated these tasks within year level area teams, and that she felt they were valuable, the point came up in the first PLT meeting observed that the results from these rich assessment tasks would not be used to inform report writing. This was mentioned on another occasion at the same meeting in this comment when discussing what to do with the student work samples. Teacher 3 stated, "Well if it's not used for reports. It's just sort of to track growth … and if it's on SPA, we've got what they have learnt" [2:32] so they decided to return the student work samples to students rather than keep hard copies.

Then again, the following year discussion around how the results of these tasks could be used was evident at a mathematics PLT meeting. Robyn described to her new team how the tasks were initiated and why she thought the tasks were part of their work. She pointed out, "the idea was that each year it would build, hopefully, and that you would see from Prep to Year 6 a progression of skills and understanding" [V#2, 00:28 - 00:35]. Discussion continued on the value of implementing the tasks, despite not being able to find a suitable method of recording whole school data. Robyn asked her team [V#2, 1:48 - 2:36]:

> **Robyn:** What do we think? Do we want to wait and find out?
>
> **Teacher 2:** Whether it transfers do you mean?
>
> **Robyn:** Or do we just get everyone to do the tasks with modifications because we talked about that last time and just hold onto the data until we are ready?
>
> **Teacher 3:** I think we wait because we don't know, do we?
>
> **Teacher 2:** You're not using the data to make an assessment of where they're at the moment?
>
> **Robyn:** Well, it gives you a picture.
>
> **Teacher 2:** It gives you a picture

Robyn: At the time

Teacher 2: But it’s not that you need that data crucially to see them.

Robyn: No. Well, they’re just open-ended tasks.

Teacher 2: And they’re already doing a lot of testing for maths and stuff.

Robyn: It doesn’t. It’s not really a test. It doesn’t feel like a test. It’s just an open-ended task.

Robyn concluded, “so maybe we will try and get them done in terms 1 and 2 and just hold onto the data.” Following further discussion, members of the mathematics PLT made some suggestions and it was decided to use some diagrams and written prompts. Teacher 1 thought that students could possibly tire of the same task if it was implemented each year from Foundation to Year 6, therefore a decision was made to design four different tasks to be implemented over a two-year cycle. However, since that meeting Robyn communicated in an email the following year [E#1, 2018]:

> No, we did not complete them. We have had to reassess these tasks over and over again. Had major issues with managing results … Maths PLT working to improve tasks so that there is differentiation across the year levels and students do not tire of doing the same task each year. Prompts will be provided to encourage students to demonstrate their best responses to the task. Due to difficulty in recording and storing data from these tasks, the Maths PLT have discussed alternate assessment measures to track student growth. We will trial the development of a suitable open-ended task at each year level that is relevant to the topic being covered each term and aiming to cover the four learning areas.

Judging from this evidence it appeared that it was difficult to find a task that could be implemented across all Year levels that would provide valuable data that could assess student growth. There were also issues with how the results were recorded and data stored which led to the team thinking of alternate ideas.

5.4.2 Mathematics leadership challenges experienced by Robyn.

5.4.2.1 Role clarity.

In her role as a School Mathematics Leader Robyn had never been given a role description. Robyn explained [I#3, May 10, 2017]:

> Sometimes I think the hard part of this job is there's no real guidance for me, like I make this stuff up because nobody's – I mean the auditing and all that, that was put upon us and I guess that came from above. But in terms of the vision for the school or where we should be going, I've had no direction on that and that's just – I've decided that.

When discussing the support that Robyn received from her principal, Robyn pointed out, “I have never sat down with her to say this is where” or asked her “where do you see that we should be going?” Robyn indicated that she understood the direction her principal wanted her to take in the following comment when asked if she wanted a role description. Robyn believed that a role description might create more work [I#4, June 7, 2017]:

> I don’t know, it might give me more. No, look I think in our brief conversations it's just, her agenda I suppose is having everybody on-board with bringing planners up to date, eliminating worksheet mentality and pigeonholing, you're Grade 3 so you do this, you're Grade 4 so you do this, because she believes that there are some teachers that teach that way. I guess what I've discussed with her with, you know, the Peter Sullivan model, she's wanting everyone to come on-board with that and so I guess that's my brief. How do I do that?

This comment reflects Robyn’s belief that, although she did not have any formal role description, the direction her principal wanted her to take as part of her mathematics leadership role, entailed encouraging teachers to use more open-ended, challenging tasks based on “the Peter Sullivan model.” However, it appeared that Robyn was left to decide how to support teachers to use more challenging tasks.

5.4.2.2 Time.

Robyn described time as the biggest challenge in her role. She explained, “I think it’s always time. That's the big one. Because I guess if they [teachers] come to you, they’re wanting help, and just being given the time, even as a whole staff.” Robyn pointed out, that until this semester, when she reduced her time fraction, she had no availability to work alongside teachers in their classrooms. She said, “I’ve not had any time, so I can’t really say, “I’ll come in and work with you,” or anything like that.” Robyn explained, “I've done a little bit of modelling [of teaching mathematics], but I guess that's my frustration. I'm not getting there [into classrooms] enough.” Classroom teaching responsibilities, in addition to subject responsibility can “be a conflicting priority” (Millett, 1998, p. 240). Consequently, Robyn explained that when she supported individual teachers [I#1, November 16, 2016]:

> That’s probably been more incidental. So, if someone comes up to me and says, "I've got this child, they're way above," or "They're way below, what can I do?" I just support them with some advice or some resources maybe to work on that.

Fullan (1995) sees the possibility of “different and better use of time,” in schools, more than the presence of more time, along with “wholesale change in the culture and organisation of schooling” (p. 233). Robyn made the point that with a change of principal, she was able to reduce her teaching time fraction and changes were made to her timetable. This allowed her to use one day a week to plan with her teaching partner, support a graduate teacher in her team and manage her leadership responsibilities. Robyn explained that her principal was prepared to fund this change which she believed was a positive step and pointed out [I#3, May 10, 2017]:

> At least the school has allowed me to do that … but I would like to expand and probably that will be my Term 4 goal … where I can do some team teaching with a couple of … teachers and just show them what can happen.

This comment reveals Robyn’s belief that team teaching and working alongside teachers is an effective way to provide learning opportunities when teaching mathematics. The comment also reveals how important having the time to support teacher learning is to Robyn and demonstrates that she is valued by the principal for her expertise.

5.4.2.3 Building mathematical pedagogical content knowledge.

According to Robyn, being involved in the local mathematics leader’s cluster and having conversations with other School Mathematics Leaders, influenced the way she enacted her role. She commented, “hearing what other schools are doing … maybe gives you some ideas. Or you talk with other leaders that, say, have the same issues and you want to work [on] a way of addressing it.” It was at one of the cluster meetings that Robyn first heard about the Encouraging Persistence Maintaining Challenge (EPMC) project.

Robyn explained, early in her role at one of the cluster meetings, Peter Sullivan shared "some video of one of the schools … that he'd been working with and talked about his projects. I just thought it was fantastic." As a result, she organised for him to run a curriculum day at her school the following year, and then became involved in the Encouraging Persistence Maintaining Challenge (EPMC) project. This opportunity and "the research … made me realise that we needed to change the way we teach here." According to Robyn, "we were doing a little bit of open-ended stuff" and "we had Rob Vingerhoets [a mathematics consultant] come and visit a few years back, and that influenced our planning." However [I#1, November 16, 2016]:

> I think bringing in the Peter Sullivan stuff to the school, I think that's been a major change in the way teachers work, and I think because we've had the three years, different teachers have come to the PDs. So, I'm building my group of followers, and then they go back and share it with the team, and then often someone else in the team has done a different one with him, and so they're on board. So, I think that's probably the thing I'm most happy about, that way of teaching. I know not everyone embraces it, but in general, most people do, and I sort of feel like that was my thing to do.

Robyn pointed out that since a whole school professional development day with Peter Sullivan and the school's involvement in the EPMC project, "people got on-board more, but we've still got a lot of old school style teachers and it's been hard to move them on."

Robyn believed that "teachers that are so set in their structured way of teaching probably just feel they can't lose the control by just putting up … a number [on the board] and saying tell me what you know, make equations about it." According to Robyn, "I think it's just giving them the confidence." She also made the point, "I think they need to be shown that it works and how effective it is." Before the end of the term, Robyn's, goal was to try and do "some team teaching with a couple of those teachers." Robyn explained [I#4, June 7, 2017]:

> Yeah, and we've got a few quite traditional teachers here who are still excellent teachers but she's [the principal] wanting them to get on-board. Because if they did get on-board, they would do it in a really good way I think, because they've got the great maths grounding, I think they're just scared to open it.

Although Robyn added:

> I've got lots of followers of the program I guess, of that style. So, I guess that each one that you bring on board. Yeah, I think I guess along the way I've picked up a few followers that are then helping. I think the more that you get on board with the [style] who can promote that it's a really good way to teach, then it makes your job easier. It's not just you against the world. I mean it never was, of course, there's always lots of teachers that are willing to try new things and then, yeah.

However, Robyn stressed one of the reasons that teachers might lack confidence with this "style" could be:

> I think, because the people who go to the PD get a whole day to work through the problems, and by doing it yourself you see what it's all about. But if you haven't done it yourself, I don't think you can get as much out of it, and really, we should be having our area meetings looking at this. But there seems to be too much stuff in the way. So, next year I'm really hoping that I can address that in the area team.

This comment reveals Robyn's belief that the most effective way for teachers to learn is by doing the mathematics tasks, which builds buy-in and commitment, a characteristic of a democratic leader. Experiencing the tasks also allows teachers to see any difficulties that might arise and possible student responses, which can contribute to building teacher confidence, and in this case, Robyn believes teachers will be more likely to use them.

5.4.2.3.1 Worksheets.

In an attempt to move on some of the "old school style teachers" Robyn took opportunities during staff and PLT meetings to continue to promote the use of open-ended tasks as opposed to worksheets. However, Robyn also made the point on at least two occasions, [29:42] and [30:02], of the need to do some explicit teaching of a topic. Robyn made her opinion clear in reference to the use of worksheets by teachers in her school in the following transcript of a discussion between members of the mathematics professional learning team [V#2, 1:12 - 3:07]:

> **Robyn:** Instead of having a set … just give them one number.

Teacher 1: I did that the other day, where I said the difference is, and I gave different groups just the answer … And the kids were going, we don't want to stop. I said, "You have to eat your lunch" and they were like, "Oh look at this Mrs. H! Look at this!" [excitedly]

Teacher 3: Yeah. How good is it?

Robyn: Yeah. It's just as simple as that. Instead of that worksheet with ten questions that some kids fly [through].

Teacher 1: Oh, yes and how often do you see algorithms. You don't.

Robyn: And then they're writing their own and they share it.

Teacher 1: Then they got all excited because they found the patterns and I'm thinking, sometimes a lesson that you don't think is that [good] is great.

Teacher 2: And finding the pattern is the task.

Robyn: That's the task.

Teacher 2: And finding the pattern is the thinking that you need in order to progress further. If you don't find the pattern you're not going anywhere.

Teacher 1: And then they wanted to do it again!

Teacher 3: Sometimes I just write like 17 on the board, give me as many equations and they love it. I'm like, how is this fun and they love it because there is not one right answer.

Robyn: Yeah, because you've been drilling like I do through the Peter Sullivan stuff and being systematic. Wherever you start going up or down or whatever, then they see a pattern and they get so excited about it.

Teacher 1: Yeah, that's right.

Teacher 3: And then you make it a bit competitive, like who's got the most.

Robyn: Excellent. Well done Teacher 1. We want more of that and that's the sort of stuff if you say to those people who like their worksheets, tell them about that lesson. [2:52]

Teacher 1: Well yes but …

Teacher 2: I don't know [shaking her head]. You are not going to convert those worksheeters.

Teacher 3: No more sheets. Save the trees.

Robyn: You don't even need paper. It's one number on the board isn't it, and it's a whole lesson and you get so much more out of it.

It appeared that the teachers in the mathematics PLT had similar views to Robyn and were making changes to the way they taught mathematics. In this case Robyn identified a clear direction and a "come with me" (Goleman, 2000) attitude, a characteristic of an authoritative leader. It could also be seen as developing a "shared, collective understanding" (p. 120) in Fullan's terms which is essential to effective leadership (2020).

5.4.2.3.2 Teacher growth.

At the second PLT meeting six months later, as Robyn was discussing items on the agenda, she commented, "I would really like to share that Peter Sullivan, 'How to turn a closed task into an open-ended task' [professional development workshop]. So maybe if I get the chance, I'll pull up some stuff for that" [V#2, 00:42 - 01:03]. Teacher 1 commented, "I'd really like to see that" [00:50], co-incidentally in the previous PLT meeting six months earlier the same teacher had expressed her interest in observing a modelled lesson with this comment [V#1, 17:28 - 17:42]:

Teacher 1: It would be really good. When you're talking about that peer coaching thing, it would be really nice, because I've never done anything with Peter Sullivan, besides what we've done in school, to actually see these lessons. I know they weren't really relevant to Prep this year.

It would appear from Teacher 1's desire to be involved in peer observations as well as this comment, that although an experienced teacher, she was eager to improve her practice and build her pedagogical content knowledge. It could be inferred that the conversations and work within her professional learning team were a contributing factor.

Teacher learning and growth are inevitable when working as part of a learning community (Clarke & Hollingsworth, 2002). "Teacher growth is constituted through the evolving practices of the teacher, which are iteratively refined through a process of enaction and reflection" (Clarke & Hollingsworth, 2002, p. 955). It was evident that Teacher 1 had reflected on the discussion that she had been part of in the mathematics professional learning team meetings and was eager to learn more.

5.4.2.4 Disengaged teacher.

It was obvious at the initial professional learning team meeting that one particular teacher was not always engaged in the meeting. As the other teachers discussed items on the agenda, there was one teacher who continued to check a planning document on his laptop computer. At one stage, this teacher read and replied to an email [V#1, 46:26 - 47:54] and then sent a message on his phone [V#1, 48:19 - 48:23]. There were periods during this time where he checked his phone and appeared to tap on it and read messages [V#1, 47:26 - 47:53]. On another occasion [V#1, 34:27 - 38:54] Teacher 2 left the meeting to catch up with a colleague. Although he added to the discussion intermittently, while the other three teachers were working together to create a slide for the junior team to use as part of a rich assessment task, he was not involved. This teacher (Teacher 2) was expected to create a slide for the Year 5/6 team. When asked by Teacher 3, "Teacher 2 are you doing this one?" [9:13] he replied, "Where's that?" He appeared to have no idea what the rest of the team were doing at that stage.

A tally of responses showed Teacher 2 contributed least to the meeting discussion with 148 responses during a one hour and eight-minute meeting. Teacher 2 gave the appearance of listening and added brief comments, but at times was clearly distracted. Whereas Teacher 1 spoke 209 times, Teacher 3 made 171 comments and Robyn spoke 330 times. It could be inferred from this evidence that Teacher 2 did not believe the work the PLT were doing was of value, but it might also mean that he had conflicting priorities or needed to sort out an urgent problem. At one stage, [47:32] Robyn quietly walked around the table and looked at Teacher 2's laptop screen but made no comment. Distraction can be a challenge when leading a team. Despite Robyn being aware of his inattention for that part of the meeting, she continued without making a point of this behaviour, another sign of her effective leadership style. Appreciating resistance (Fullan, 2001) is a sign of effective leadership and it was clear during the observation that Robyn was aware that Teacher 2 was at times, distracted by other matters but did not draw attention to this issue.

5.4.3 Success in leading mathematics: Robyn.

5.4.3.1 Leadership style.

As the School Mathematics Leader, Robyn made a concerted effort to seek the opinions of teachers in her mathematics professional learning team. At the first observation when teachers were discussing which assessment tasks to add to SPA [Student Performance Analyser], Robyn asked, “Do you think we can ask people to go back?” [V#1, 1:58 - 2:01] Following this, Teacher 1 asked for further clarification, and again Robyn sought the opinion of all her team members, when she asked, “What do we think?” [2:09] which demonstrates the collaborative nature of Robyn’s leadership style. The video evidence of the second PLT meeting also showed that Robyn had asked teachers in the mathematics professional learning team their ideas when discussing if they should continue to implement the rich assessment tasks, with the question, “What do we think?” [01:48] Then she followed with, “Do we want to wait and find out?” [01:50] and then added “or do we just get everyone to do the tasks with modifications, because we talked about that last time, and just hold onto the data until we are ready?” [V#2, 01:55 - 2:07]

Spending time to get teachers “ideas and buy-in builds trust, respect, and commitment” (Goleman, 2000, p. 85). This democratic leadership style was evident in the meetings observed. This leadership style is also used when a leader is unsure of the best direction to take and “forges consensus through participation” (Goleman, 2000, p. 83) which seemed to be the case with the implementation of the rich assessment tasks across the school. During an interview [I#1, November 16, 2016] and in a mathematics PLT meeting [V#2, 04:08] Robyn stated that these tasks were “a work in progress.” At one of these meetings Robyn asked teachers, who were about to move off and work on different projects, “Who would like to look at the rich assessment tasks?” There was no immediate response, consequently she added, “Don’t all put your hand up at once.” Although not all the teachers in attendance at the meeting appeared enthusiastic, which was apparent during an observation, several teachers did offer suggestions and two teachers at the time spent the rest of the meeting working on improving and extending the number of tasks.

5.4.4 Successes and challenges: Robyn.

5.4.4.1 Reflecting on the School Mathematics Leader role.

When reflecting on her role as a School Mathematics Leader Robyn pointed out, “it’s been good. I’ve enjoyed it. And I feel like we’ve achieved a lot, apart from the time constraints of not having enough meetings.” Robyn explained “we generally have a couple of meetings a term, either the professional learning team … and then area meetings, the other Wednesdays, and then staff meetings Tuesdays."

Judging from comments Robyn communicated at the first interview, it appeared that the meeting schedule at her school was very 'busy,' and the number of allocated mathematics professional learning team meetings was inconsistent. Robyn pointed out, "but I think it's just, again, the lack of time, the busy schedule. There's so much else that goes on in those meetings." The lack of opportunity for a mathematics focus at a whole school staff meeting was also an issue. According to Robyn, "every year on our plan it's like having more time is a recommendation. I think in principle, the leadership agrees that it should happen, but if you can get one [meeting] a term you're doing really well." Robyn expressed her frustration with this comment [I#1, November 16, 2017]:

> One staff meeting a term, yeah, and unfortunately up until this date, our curriculum days were set without any consultation, and we were just sort of told this is what's happening. So, I'm hoping with new leadership that might change because I think people get annoyed with that [lack of consultation].

While observing a professional learning team meeting, teachers in the mathematics team were discussing follow-up to the implementation of a whole school rich assessment task, initiated by their team. When discussing how the results would be recorded in their teams, Teacher 1 asked, "Are we just going to show … [teachers] SPA (Student Performance Analyser) and put … [the results] onto SPA, because we were going to do it at a staff meeting?" [00:58] Robyn replied, "Yeah, but I don't think there is one. I think we just have to get on with it," [01:07] indicating the meeting schedule was busy, and that this recommendation by the mathematics team was not seen as a priority. When explaining the progress of members of his team, Teacher 2 explained, "I'm assuming they've done it … so I'll touch base with them" [00:46] and Robyn added, "when we eventually have an area meeting." [00:56] In a prompted written reflection [WR#2, R] Robyn also noted that meetings were inconsistent and other priorities got in the way. She recorded her thoughts in this comment, "this meeting was arranged with no notice so very little formal planning." I could sense her frustration at the lack of organisation and consultation from leadership. However, Robyn also wrote, the "meeting went well, new team seems dedicated and motivated to achieve this year."

Although Robyn made the point, “you don’t want a lot of meetings,” she also pointed out “going from one term to the next and trying to keep momentum on tasks has been sometimes frustrating.” However, she also explained, “but I’ve always had teams that really put in and will carry on with things away from the session … I’ve had supportive teams and I feel like we have achieved some changes.” It appeared from the video evidence and my observations that Robyn liked to be well prepared for meetings. Prior to three mathematics professional learning team meetings I attended and observed, Robyn had previously prepared a detailed agenda and had copies of relevant documents such as the School Strategic Plan or assessment tasks to give to team members. This preparation demonstrated her commitment to leading mathematics and ensured the meetings were productive, constructive and ran smoothly.

5.4.5 Building professional learning communities: Robyn.

Robyn contributed to building a professional learning community in her school through the mathematics professional learning team. It was through her work with this team, and also on a school wide basis in leaders’ meetings, staff meetings and Year level team meetings that Robyn continued to build her professional learning community and her team. Robyn referred on several occasions to her “followers.” The “followers” were the teachers she believed had adopted “that style” that she described was “a really good way to teach” mathematics. Robyn also referred to it as the Peter Sullivan model. However, Robyn explained, “trying to get it through to the masses” was a challenge. She pointed out, “I found we had a few [followers], and that’s made a big difference, but not enough, in terms of trying to spread the word.” Robyn commented, “I think the more that you get on board with that [style] who can promote that it’s a really good way to teach, then it makes your job easier.” Building her team was important to Robyn as was supporting teachers to build their mathematical knowledge for teaching,

Although Robyn faced certain obstacles in relation to planning, she did meet regularly with members of her mathematics professional learning team where she passed on her philosophical ideas, curriculum issues were discussed, and her leadership practice was defined. “Leadership practice (both thinking and activity) emerges in and through the interaction of leaders, followers, and situation” (Spillane et al., 2001, p. 27). In this case it was the interactions that occurred between Robyn and teachers at her school and the actions in promoting “that way of teaching,” that helped define her leadership practice (Spillane et al., 2001) and build her professional learning community.

In summary, the evidence showed Robyn as an effective leader who constantly worked on developing relationships (Fullan, 2020) and supported several teachers at her school on an individual basis in classrooms and with their mathematics planning. The majority of Robyn's support occurred as she led the professional learning team meetings. Despite several challenges described by Robyn, she continued to remain optimistic and delivered her message and vision of effective mathematics teaching and learning to other teachers in her school.

Next, results from chapters 4 and 5 will be discussed in a cross-case analysis. The themes that emerged from the level 3 analysis of the data will form the basis for a comparison of similarities and differences between the four School Mathematics Leaders.

Chapter 6: Cross-Case Analysis of the Case Studies

The results reported in the previous two chapters, Phase 1: Survey and Phase 2: Case studies, provided detailed evidence of the ways in which each School Mathematics Leader supported teachers' professional learning. In this chapter, the four main themes that emerged from the cross-case analysis of the case study data will be presented and discussed and similarities and differences between the cases will be identified.

6.1 Cross-case Themes Applied to Research Question

The four themes that emerged from the cross-case analysis are presented and structured using the research questions. The first two themes are discussed in relation to research question one – how leaders support professional learning. The third theme is considered in relation to research question two – what challenges and successes School Mathematics Leaders report. The fourth theme contributes to answering research question three – what School Mathematics Leaders experience as they build professional learning communities.

6.2 Research Question 1

Research Question 1: How do School Mathematics Leaders support primary teachers' professional learning?

The context in which the School Mathematics Leaders worked and the manner in which they led mathematics were very different. However, the cross-case analysis revealed many similarities as well as differences in how each School Mathematics Leader supported teachers professional learning in their schools and the challenges and successes they experienced. The School Mathematics Leaders supported teachers professional learning by:

1. Developing teachers' mathematical knowledge for teaching;
2. Working alongside teachers in the classroom to create opportunities for teacher learning;
3. Implementing effective mathematics leadership; and
4. Fostering opportunities for team collaboration and collegial support.

In the next section each of these themes will be described in full.

6.2.1 Theme 1: Developing teachers' mathematical knowledge for teaching (MKT).

The four School Mathematics Leaders in the case studies worked to build teachers' mathematical knowledge for teaching (MKT), which can be defined as the overarching construct that combines mathematical content knowledge (MCK) and pedagogical content knowledge (PCK). Each School Mathematics Leader developed MKT in different ways, but with the same intention, as stated by Gaffney, Clarke and Faragher (2014) teachers need to "know their mathematics and know how to teach it" (p. 4).

The actions of each School Mathematics Leader as they supported teachers to develop their MKT were compared using a matrix and then recorded in Table 6.1. Close examination of the case study data presented in Chapter 5 confirmed that through these actions, the four School Mathematics Leaders supported teachers in their schools to build their MKT. Check marks (✓) indicate the presence of this action in the data set of each School Mathematics Leader.

Table 6.1

School Mathematics Leaders' Actions in Supporting Teachers to Build their MKT

	School Mathematics Leaders' Actions	Susan	Jane	Amy	Robyn
a	Co-facilitated and planned mathematics lessons with teams of teachers	✓	✓		
b	Planned mathematics lessons with individual teachers			✓	✓
c	Supported teachers during planning meetings to choose the most appropriate tasks and select suitable models and materials	✓	✓	✓	✓
d	Instructed teachers as to what to include in their planning.	✓	✓		
e	Challenged teachers' MCK while supporting them to learn as they planned lessons/tasks		✓		✓
f	Developed a curriculum document used to assist with mathematics planning	✓	✓		
g	Facilitated and planned mathematics professional learning team meetings	✓	✓		✓
h	Attended mathematics professional learning team meetings	✓	✓	✓	✓
i	Worked alongside teachers in the classroom, modelling, team teaching, mentoring, offering expertise and knowledge	✓	✓	✓	✓
j	Supported teachers through incidental conversations related to mathematics	✓	✓	✓	✓
k	Suggested mathematics professional reading	✓	✓	✓	✓
l	Guided and coached Year level team leaders	✓	✓		
m	Analysed and discussed assessment tasks and student work samples during moderation	✓	✓	✓	✓
n	Created and refined a range of whole school 'rich' assessment tasks			✓	✓
o	Facilitated and presented whole staff professional development in staff meetings	✓	✓	✓	✓

Findings from this study confirm that School Mathematics Leaders are an important link in supporting teachers to build their mathematical knowledge for teaching (MKT). These results are consistent with earlier research (Faragher & Clarke, 2014; Gaffney, Bezzina, et al., 2014; Jorgensen, 2016; Millet & Johnson, 2007). While the ways in which each School Mathematics Leader supported teachers to learn varied from leader to leader and school to school, there were seven (c, h, i, j, k, m, and o) aspects that all leaders had in common which included:

1. An aim to improve teachers MKT (c, h, j, k, m and o);

2. Involvement in collegial discussions related to mathematics during planning and professional learning team meetings (c, j and m);
3. Participation in shared experiences and discourse in classrooms (i and j);
4. Analysis of responses to assessment tasks and discussion of student work samples (m); and
5. Presentation of mathematics professional development to teachers in their schools (o).

Notable differences in the ways in which each School Mathematics Leaders supported teachers to build their MKT were that they:

1. Planned mathematics lessons in collaborative teams (a);
2. Planned mathematics lessons with individual teachers (b);
3. Instructed and challenged teachers during planning which reflected their leadership style (d and e);
4. Facilitated and organised professional learning team meetings (g);
5. Created tasks and provided resources to assist with mathematics planning (f and n); and
6. Guided and coached Year level team leaders (l).

The results of the study reveal that although all four School Mathematics Leaders supported teachers to plan mathematics lessons, only one leader involved in the case studies was able to attend all Year level planning on a weekly basis. All four leaders attended professional learning team meetings and worked in classrooms to varying extents where they were able to share their expertise and knowledge. It was apparent that Susan, Jane and Amy had more time to support teachers while Robyn provided limited support to teachers because she was a full-time classroom teacher. Robyn had very little time, yet through the mathematics professional learning team and incidental discussions, she encouraged teachers in her school to include more open-ended and challenging problem-solving tasks in their planning. Robyn modelled best practice in her own classroom and was an example of the practices she was advocating. The second theme that became apparent following analysis involved working in teachers' classrooms.

6.2.2 Theme 2: Working alongside teachers in the classroom to create opportunities for teacher learning.

The findings suggest that working in classrooms was an effective way that School Mathematics Leaders were able to support teachers to learn. Creating opportunities for teacher learning through knowledge creation and sharing is an important element of effective leadership (Fullan, 2002). However, the self-reported evidence from both the surveys and the case studies indicated that the extent of this opportunity to learn in the classroom varied enormously from school to school. Table 6.2 presents comparisons between cases and outlines the practice of each School Mathematics Leader as they worked in classrooms.

Table 6.2

Working Alongside Teachers in Classrooms

	School Mathematics Leader Practice	Susan	Jane	Amy	Robyn
a.	Participated in shared experiences and discourse around student learning	✓	✓	✓	✓
b.	Involved in modelling, mentoring and team teaching	✓	✓	✓	✓
c.	Observed teacher practice and provided feedback	✓	✓	✓	
d.	Offered expertise and knowledge as support from a more experienced other	✓	✓	✓	✓
e.	Encouraged and participated in reflective practice	✓	✓	✓	✓
f.	Made connections between previous knowledge and new understandings	✓	✓	✓	✓
g.	Situated teaching in meaningful and relevant contexts	✓	✓	✓	✓
h.	Contributed to building teacher confidence in teaching mathematics	✓	✓	✓	✓
i.	Dedicated specific time to work with individual teachers in classrooms			✓	✓

There were some common practices that each School Mathematics Leader displayed when supporting teachers in the classroom. For example, the School Mathematics Leaders:

1. Participated in shared experiences and discourse around student learning (a, b, d, e, f and g);
2. Engaged in modelling, mentoring and team teaching (a, b, d, f and g);
3. Encouraged and participated in reflective practice (a and e);
4. Offered expertise and knowledge as a support to teachers (a, b, d, f and g);
5. Supported teachers in meaningful and relevant contexts (a, b, d, f and g); and
6. Contributed towards building teacher confidence (h).

Some notable differences were that the School Mathematics Leaders:

1. Observed teacher practice and provided feedback (c); and
2. Dedicated specific time to work with individual teachers in classrooms (i).

In this study each School Mathematics Leader, at various stages and to different extents, supported teachers to learn in their classrooms as they shared and discussed pedagogy and curriculum. Using teachers' own classrooms is "a powerful context for … enhancing teacher learning by creating a supportive professional community" (Koellner et al., 2011, p. 117).

The next theme that became apparent was effective mathematics leadership.

6.3 Research Question 2

Research Question 2: What challenges and successes do School Mathematics Leaders report when supporting primary teachers' professional learning?

6.3.1 Theme 3: Effective mathematics leadership.

A key assumption underpinning this research is that School Mathematics Leaders who are effective are better able to support teacher learning. However, the effective leadership of mathematics is dependent on certain conditions which may create challenges or contribute to leadership success. This study found that School Mathematics Leaders have the potential to be effective when: time is available for their work, they understand the expectations of their role, they have the confidence to make decisions and act accordingly and the relationships they have with their principals and teachers are constructive. Table 6.3 presents comparisons between cases and outlines contributing factors towards the effective leadership of mathematics.

Table 6.3

Effective Mathematics Leadership is Reliant on Contributing Factors

	Factors That Contribute Towards Effective School Leadership	Susan	Jane	Amy	Robyn
j.	Time to fulfil the responsibilities of mathematics leadership	✓	✓	✓	
k.	Expectations of the leadership role are clear	✓	✓		
l.	Knowledge of leadership	✓	✓	✓	✓
m.	Constructive relationship with the principal and principal support	✓	✓	✓	
n.	Constructive relationships with the majority of teachers	✓	✓	✓	✓
o.	Knowledge, confidence and expertise to support teacher learning	✓	✓	✓	✓
p.	Professional learning to develop their own mathematical knowledge for teaching	✓	✓	✓	✓

Findings from this study showed that all four case study participants demonstrated aspects of effective leadership. While there were many similarities in the factors that contributed towards the effective leadership of mathematics practiced by each School Mathematics Leader, there were also many differences. Similarities included:

1. Using their knowledge of a range of different leadership skills (l);

2. Establishing constructive relationships with most teachers in their schools (n);

3. Having a certain degree of confidence and expertise that allowed them to support teacher learning (o); and

4. Engaging in on-going professional learning (p).

Notable differences in the factors that contributed towards effective leadership included:

1. Time allocated to lead mathematics (j);

2. Being clear about the expectations of the leadership role (k); and
3. Having a constructive relationship with the school principal and their support (m).

While time to lead mathematics continued to be an issue in this study and impacted on the effectiveness of the support that could be provided, so too was principal support. Three of the four School Mathematics Leaders initially believed they had the full support of their principals', but this changed over the period of the study and became inconsistent for two of the leaders. Principals and School Mathematics Leaders need to work in collaboration to lead improvement in mathematics (Gaffney, Faragher, et al., 2014). Decisions made by the principal related to the organisation of resources and staffing and in school structural changes impacted the effectiveness of the School Mathematics Leaders' work (Gaffney, Bezzina, et al., 2014). Constructive relationships with teachers were also important. Effective leaders are aware of differences, appreciative of resistance and focus on building relationships (Fullan, 2001). Each School Mathematics Leader worked hard at developing positive relationships with teachers at their schools despite some occasional resistance.

The next theme that became apparent involved teachers working together in collaborative teams.

6.4 Research Question 3

Research Question 3: What challenges and successes do School Mathematics Leaders experience as they build professional learning communities?

6.4.1 Theme 4: Fostering opportunities for team collaboration and collegial support.

In this study, each School Mathematics Leader played a critical role in supporting teachers to build their professional learning community to varying degrees by encouraging team members to work collaboratively to enhance their knowledge about the teaching and learning of mathematics. This finding is consistent with an emphasis in the literature on the impact that teachers working collectively in teams can have on student and teacher learning (Hattie, 2012; Du Four et al., 2010). The literature also described learning as the result of participation in a community of practice (Lave & Wenger, 1991). Working in collaborative teams to support teachers' professional learning was an expectation at both Susan and

Jane’s schools, but to a lesser extent at Amy and Robyn’s schools where it was not seen as a priority.

In Table 6.4, comparisons between cases are presented and the ways in which each School Mathematics Leader fostered opportunities to develop collaborative teams and provided support to teachers are outlined.

Table 6.4

School Mathematics Leaders’ Actions in Fostering Opportunities for Team Collaboration and Collegial Support

	School Mathematics Leaders’ Actions	Susan	Jane	Amy	Robyn
q.	Co-facilitated and planned mathematics lessons with teams of teachers	✓	✓		
r.	Facilitated and planned mathematics professional learning team meetings	✓	✓		✓
s.	Attended mathematics professional learning team meetings	✓	✓	✓	✓
t.	Established processes and protocols for working with teams of teachers	✓		✓	
u.	Rescued and reassured teachers attempting to create harmony within the team			✓	
v.	Supported and encouraged teacher discourse related to student learning during meetings	✓	✓	✓	✓
w.	Built consensus through questioning to get teacher ideas and buy-in	✓			✓
x.	Built positive relationships with teachers to establish trust, respect and commitment	✓	✓	✓	✓
y.	Noticed some form of resistance from a member of the team	✓	✓	✓	✓

Meetings allowed teachers to feel supported as part of a team where relationships were built (Fullan, 2001). Similarities between the ways in which the School Mathematics Leaders fostered opportunities for teams to collaborate and support teacher learning included:

1. Working collaboratively in a team with a specific focus (s, v and x);
2. Engaging in teacher discourse related to student learning (s, v and x);
3. Attempting to build positive relationships to establish trust, respect and commitment (v and x); and
4. Experiencing and dealing with some form of resistance from team members (y).

Notable differences between the ways in which the School Mathematics Leaders fostered opportunities for team collaboration included:

1. Co-facilitating and planning mathematics lessons with teams of teachers (q);
2. Facilitating and planning the focus of professional learning team meetings (r);
3. Establishing processes and protocols for working with teams of teachers (t);
4. Type of leadership practice (t, u and w); and
5. The ability to build consensus through questioning (w).

In summary each School Mathematics Leader encouraged team collaboration in an attempt to help teachers to learn collectively during planning and in professional learning team meetings, to the extent that their available time allowed.

The themes which emerged from the cross-case analyses of the data were examined in this chapter. A comparison was made of some of the commonalities and differences the School Mathematics Leaders experienced when supporting primary teachers' professional learning. The findings identified in the cross-case analyses are key to the discussion in the next chapter when connections will be made to the literature and points will be elaborated on further.

Chapter 7: Discussion

The findings that emerged from the Phase 1: Survey and Phase 2: Case studies will be discussed in relation to the research questions that framed the study. Drawing on the theoretical lenses used to frame this study, Lave and Wenger's (1991) belief that learning takes place as part of social practice, and Fullan's (2001) Framework for Leadership as well as the literature review, each of the three research questions will be addressed in turn.

> *Research Question 1*: How do School Mathematics Leaders support primary teachers' professional learning?

The findings showed that primary School Mathematics Leaders supported teachers' professional learning by:

1. Supporting teachers' mathematics planning
2. Working with teachers in professional learning teams
3. Developing constructive relationships with principals and teachers
4. Engaging in on-going professional learning
5. Working alongside teachers in their classrooms.

This research found that School Mathematics Leaders supported teacher professional learning during collegial meetings, including planning and professional learning team meetings. The evidence showed that support was also provided as the School Mathematics Leaders developed constructive relationships with principals and teachers and engaged in on-going professional learning to develop their own mathematical knowledge for teaching and leadership practice to support their team members.

This study was framed around interviews and observations of the School Mathematics Leaders' and teachers' actions and interactions during the team meetings. Following a detailed analysis of the data, a further finding became apparent. It became evident that School Mathematics Leaders worked alongside teachers in classrooms and that this action was a potentially valuable way of supporting teachers to learn to be better teachers of mathematics. Although this practice was not observed in the realms of this study and is based on the self-reported evidence provided by the School Mathematics

Leaders in interviews and a survey, the finding warrants recognition and has therefore been included in this discussion chapter.

To answer the first research question, the five findings listed above will be discussed in detail in the following section. Further findings will be discussed when responding to the second and third research questions.

7.1 Supporting Teachers' Mathematics Planning

School Mathematics Leaders supported teachers by offering guidance and advice as they participated in planning meetings. Responses (36%) to the survey indicated that the School Mathematics Leaders believed they supported teachers with planning mathematics lessons. Similarly, findings from each case study observation highlighted the important role that the School Mathematics Leader played in supporting teams of teachers during planning. The leaders helped teachers by building a sense of community as they planned together (Gaffney, Faragher, et al., 2014). Working collaboratively in teams provided an opportunity for sharing of ideas, shared decision making, and shared responsibility for student learning (DuFour et al., 2010). The School Mathematics Leaders encouraged teacher collaboration as a means of developing a common understanding of the content taught, and ways to evaluate the impact of planning on student learning. Together, teachers and School Mathematics Leaders also decided on the direction to take with planning and where to go to next, based on their knowledge of curriculum and student needs (Absolum, 2006; Hattie, 2012; Timperley, 2008).

This study showed that teachers needed support during planning to understand the 'important ideas' on which to focus, the connections between underpinning concepts, and possible sequencing of these ideas. Similar findings were revealed in the work of Sullivan, Clarke, Clarke, Farrell and Gerrard (2013). As teachers planned mathematics lessons with the support of the School Mathematics Leaders, they drew upon a variety of assessment data and curriculum documents, then discussed and selected appropriate activities. The School Mathematics Leaders often prompted teachers to choose the most appropriate tasks based on the effective teaching and learning of mathematics. However, the challenge experienced by the School Mathematics Leaders was to know when to prompt and 'press' for ideas to add to the planning, as opposed to 'telling' teachers what to do.

Although in Australia it appears to be a common approach for primary teachers to plan units of work in teams (Davidson, 2016), and despite many known advantages of team collaborative planning (Hattie, 2012), this practice was missing from two of the schools in which the School Mathematics Leaders worked. Planning in collaborative teams did not occur for several reasons, including timetabling constraints and teacher and principal priorities. While teachers in these two schools were given approved time release from their classroom to plan, they did not always see the value of spending time to plan collaboratively in teams, as it required giving up their preparation time release to do so. Teachers are required to juggle an increasing workload; therefore, they need to be convinced that meeting collaboratively will benefit them in terms of saving preparation time and "potential gains in effectiveness and efficiency" (Johnson & Scull, 1999, p. 36). Teachers also need to see the value of working together in terms of learning opportunities for themselves and their students. Organising a time when all teachers from a Year level team are free from classroom responsibilities at the same time is difficult in any school, and has been the situation for decades, as Johnson and Scull (1999) noted. Planning as a whole team at these two schools was not a priority, therefore the School Mathematics Leaders supported these teachers to plan on an individual basis with lesson ideas and sharing of teaching and learning resources.

In summary, each School Mathematics Leader supported teachers' professional learning during planning, whether it was by working with teachers in teams or individually. Davidson (2016) described the necessity of deep knowledge for teaching as a critical issue in planning. The School Mathematics Leaders in the present study, who shared the depth and breadth of their mathematical knowledge for teaching, supported teachers to learn and improve their mathematics lesson planning. This finding echoes previous research findings by Ma (1999).

7.2 Working with Teachers in Professional Learning Teams

School Mathematics Leaders supported teachers to learn during professional learning team (PLT) meetings. The School Mathematics Leaders in this study expressed the view that many teachers in their schools needed to develop their mathematical knowledge for teaching. While the School Mathematics Leaders understood that it takes time for teachers to become "knowledgeable, skilled and confident in teaching mathematics" (Gaffney, Clarke, et al., 2014, p. 4), they provided support in the PLT meetings as they shared their knowledge and expertise. School Mathematics Leaders offered lesson ideas, posed questions, challenged teacher thinking and sometimes prompted and pressed teachers to contribute to discussions.

7.2.1 Mathematics professional learning team meetings.

Effective mathematics professional learning team meetings focused on collective responsibility and were directly linked to student learning, creating opportunities for teachers to learn. This finding resonated with results reported by Johnson and Scull (1999) who argued that taking responsibility for the learning of all students is a critical characteristic of professional learning teams. Teams in this study worked collectively and created meaningful learning opportunities based on either school priorities, teacher needs, or the cohort of students. Mathematics professional learning team meetings were part of the practice in each of the four schools in this study.

However, the structure and purpose of each mathematics professional learning team meeting differed from school to school. In three of the four schools involved in the case studies, the School Mathematics Leaders led the meetings and decided on the focus of the meetings. Teachers were guided to participate in activities that directly linked to student learning. These ranged from analysing student assessment data to creating assessment tasks. The focus of the professional learning team meeting at two schools was on moderation of student work samples, while at another school the focus was on the reading and discussion of an article related to the proficiencies in the mathematics curriculum.

The School Mathematics Leaders in this study believed in and promoted the benefits of working in teams as they discussed and analysed student work samples and created assessment tasks. However, while each professional learning team meeting provided opportunities for groups of teachers to learn together (Gibbons et al., 2017), there was evidence to suggest that not all meetings ran smoothly. In three of the schools when mathematics professional learning team meetings were observed in this study, tensions between some teachers were apparent. The ways in which the School Mathematics Leaders dealt with these tensions and the consequences of their actions were dependent on their leadership skills and personal qualities. The evidence showed that each individual School Mathematics Leader confidently dealt with these tensions in their own way, while continuing to focus on the learning opportunities for all teachers involved. For example, in one case the School Mathematics Leader listened respectfully to the teacher concerned, while another attempted to ‘rescue’ the particular teacher who was the centre of the tension, with encouraging comments.

Leaders of meetings are responsible for building relationships (Fullan, 2001) and providing opportunities to ensure learning gains for both the teachers and the students.

Mathematics professional learning teams were more effective when teachers spent the time on professional collaboration that had a positive impact on student learning. The use of everyday work-related opportunities such as professional learning team meetings improved teacher practice and teacher growth, a finding that is consistent with the work of Clarke and Hollingsworth (2002). A particular example where professional collaboration was evident in this study was the moderation of assessment tasks which is described below.

7.2.1.1 Moderation of assessment tasks.

Assessment of students' mathematical learning was frequently the focus of professional learning team meetings. One particular way that the School Mathematics Leaders in this study supported teachers to develop their knowledge of mathematics for teaching was through moderation of student work. Samples were gathered through the completion of rich assessment tasks. At one school, teachers were involved with designing and implementing a series of rich assessment tasks that were used to track student progress from year to year. While some teams were more effective at moderation than others, and more open to sharing student work samples and discussing evidence of student learning, the discussion around the student work provided valuable learning experiences related to how students learn. Through the sharing of their expertise and wealth of knowledge, the School Mathematics Leaders supported teachers and contributed towards teacher professional growth by detailing and discussing students' strategic thinking and possible misconceptions by students.

7.3 Developing Constructive Relationships with Principals and Teachers

The relationship between the School Mathematics Leader and the principal is an important one. Developing a constructive relationship with the principal enhances the role of mathematics leadership. This finding was confirmed by the survey data which showed that the degree of principal support for the School Mathematics Leader role impacted on the ways in which teachers were supported. Analysis of the survey data showed that three quarters of the respondents (75%) rated their principal support as eight or more out of ten, which indicated that they believed they were working well with their principal, and that their role was valued and supported. This finding was also consistent with each of the case studies and evidence presented in the previous chapters. Previous research has found that relationships, a shared purpose, and success in schools were found to be closely linked (Fullan, 2001).

7.3.1 Relationships with principals.

The relationship that existed between the School Mathematics Leaders and principals in this study had a huge impact on how support was provided to teachers. The principal is the key in terms of decision making related to structural aspects of the school, such as staffing, resourcing, and funding of the mathematics leadership role. The principal's decisions determined the allocated time dedicated to mathematics leadership and whether the School Mathematics Leader was expected to perform the role in conjunction with classroom teaching responsibilities.

It was found that effective principals develop and sustain relational trust when they respect and acknowledge others, and actively listen to their concerns. Initially, three of the four School Mathematics Leaders in the case studies believed they were able to make decisions related to leading mathematics in their schools, based on a high level of relational trust that had been established with their principals. Bryk and Schneider (2003) found similar results in their work. These School Mathematics Leaders believed the decisions they made would be endorsed and supported by the school principal, either directly or indirectly. Each School Mathematics Leader felt confident that they could approach their principal at any time to discuss matters, including proposals and issues related to leading mathematics. However, relationships became complicated due to changed circumstances, and in two of the schools in this study, principals took leave, and this change led to uncertainty. Working collaboratively with a principal and establishing new relationships proved challenging. As the schools' context changed and principals changed, the School Mathematics Leaders continued to support teachers as best they could until there was more stability of school leadership and a new relationship of trust was established.

The support that the School Mathematics Leaders believed they had, in terms of the intellectual and emotional support of the principal, also made a difference to how they perceived their leadership role, and how they enacted their role. The establishment of a trust relationship with the school principal instilled a sense of confidence in the School Mathematics Leaders. This relationship contributed to a self-assurance that allowed the School Mathematics Leaders to implement what they felt was valuable, and what they needed to do to support the teaching and learning of mathematics in their schools. A relationship based on a high level of trust, made a difference to the way the School Mathematics Leaders and principals worked together as members of a learning community. Building constructive relationships is one way to foster ongoing growth and development of all members of a school community. This view was also expressed by Du Four and colleagues (2010).

Effective leaders are relationship builders who foster purposeful interactions and develop relationships (Fullan, 2001, 2020). A constructive relationship with the principal validated and publicly endorsed the School Mathematics Leader role, which in turn, positively influenced how the School Mathematics Leaders were viewed in their school, and how they were seen as a leader. This relationship gave the School Mathematics Leaders, in the present study, credibility in the school. An investment in positive relationships is an important quality of an effective leader, which can lead to better outcomes for all. When the relationship between the principal and the School Mathematics Leader was a productive one, the teachers benefited indirectly through decisions made and support provided.

7.3.2 Relationships with teachers.

Developing constructive relationships with both principals and teachers was important to the School Mathematics Leaders in this study. It was the perception of the School Mathematics Leaders in the case studies that they had a good working relationship with the majority of the teachers in their schools. The School Mathematics Leaders suggested that they took the time to build good relationships through their daily interactions. However, there were some teachers who on occasions, and for various reasons, demonstrated some forms of resistance, which led to some tension. This point also came out in the responses to the survey, when nearly a third (37%) of the School Mathematics Leaders described forms of resistance from some teachers in their schools. Despite this perceived tension, the School Mathematics Leaders continued to take positive steps towards developing productive relationships with all teachers. Appreciating resistance is a sign of effective leadership and establishing positive relationships "among diverse elements in the organisation, including those who raise objections, is essential" (Fullan, 2001, p. 76). The School Mathematics Leaders in this study were aware of differences, understood resistance, and focused on building relationships to help achieve their desired results.

Relationships are complicated, but at the same time are crucial and make a difference to the success of an organisation (Fullan, 2001). The development of relational trust with colleagues was critical to leading mathematics successfully. Relational trust was demonstrated by the School Mathematics Leaders consistently showing interpersonal skills such as interpersonal respect, personal regard for others, role competence and personal integrity (Bryk & Schneider, 2003).

While the School Mathematics Leaders' effectiveness required both the principal and the School Mathematics Leader working together to lead improvement in mathematics (Gaffney, Bezzina, et al., 2014), it was the relationships that were critical. Enhancing the skills and knowledge of teachers in schools through building positive relationships in a professional learning community created a productive learning environment and supported teachers to learn (Fullan, 2001).

7.4 Engaging in Ongoing Professional Learning

An interesting finding which emerged from the case study data was that each School Mathematics Leader engaged in ongoing professional learning to improve their mathematical knowledge for teaching. In turn, the knowledge and skills the School Mathematics Leaders gained influenced their ability to lead effectively, and the extent of support they were able to provide for teachers. While it is critical for effective teaching of mathematics, that all teachers know the relevant content knowledge and know how to teach it (Anthony & Walshaw, 2009; AITSL, 2011, 2017), it is also important that School Mathematics Leaders are confident and knowledgeable practitioners. School Mathematics Leaders need to be seen as people with some expertise in teaching mathematics (Gibbons, 2012), without being seen as an 'expert' in all areas (Gaffney, Faragher, et al., 2014). There is a fine line here, because the School Mathematics Leaders in the present study did know a great deal, but could not possibly know everything, as they continued to lead and learn. This ongoing learning was also described by Fullan and Scott (2016). Engaging in ongoing professional learning supported the School Mathematics Leaders to develop the knowledge, skills and increasing confidence to lead groups of teachers in their school. The fostering of knowledge building and sharing in an organisation is an important element of effective leadership (Fullan, 2020).

As reported in Chapter 5, there were many available opportunities for the School Mathematics Leaders to learn. Opportunities included conferences and courses related to mathematics education and leadership that were associated with the Victorian Department of Education, universities and mathematics associations. Three of the four School Mathematics Leaders in the case studies took the initiative to commit to further university study while teaching. The same School Mathematics Leaders had also completed training in various leadership courses. Three of the four School Mathematics Leaders had also been involved in research projects associated with a university and worked with external experts in their own school context. This work was a further opportunity for the School Mathematics Leaders to broaden and deepen their professional knowledge and draw upon the expertise and experience of those involved. Engaging in ongoing learning contributed to improving the School Mathematics Leaders’ knowledge and skills and supported them to become more effective mathematics leaders. A similar conclusion was found in studies on mathematics leadership by Cheeseman and Clarke (2006) and Faragher and colleagues (2014).

7.4.1 Learning by doing.

While much of the learning experienced by the School Mathematics Leaders was away from the normal work situation, a large majority of learning occurred while working with teachers and leaders *on-the-job* in schools. The School Mathematics Leaders were all experienced teachers, but when they began leading mathematics in their schools, they were not experienced leaders. As reported in the Chapter 5, each School Mathematics Leader explained that they learnt as their role evolved. Making the most of learning opportunities contributed to building the School Mathematics Leaders’ confidence and their ability to support teachers. Learning in a school setting brings great benefits when it is in context with teachers in the school (Fullan, 2001). As each School Mathematics Leader enacted their role, they continued to learn by doing the actual tasks associated with leading mathematics, which is reminiscent of the findings of Du Four and colleagues (2010). This practice allowed teachers to see the School Mathematics Leaders as ongoing learners. Learning *on-the-job* gave the School Mathematics Leaders credibility, and also built their own sense of self-worth and self-confidence.

7.4.2 School Mathematics Leaders’ network.

Creating new knowledge through partnerships and networks was an additional means by which the School Mathematics Leaders continued to learn. This practice was also identified by Gaffney and colleagues (2014). The establishment of local networks highlighted the importance of School Mathematics Leaders’ working collaboratively and providing support through these partnerships. Cheeseman and Clarke (2006), in their work on mathematics leadership, also recommended establishing support networks to maximise benefits of the role. All four School Mathematics Leaders in this study were involved in local regional mathematics leaders’ networks. The networks provided the School

Mathematics Leaders with the opportunity to establish links with colleagues in similar roles at other schools. These opportunities allowed the School Mathematics Leaders to learn more about effective mathematics teaching across a wider learning community, which in turn equipped them to support teachers more effectively in their own schools.

7.5 Working Alongside Teachers in Their Classrooms

An important finding of this study identified the potential that School Mathematics Leaders have in supporting teachers to learn while working alongside them in their classrooms. As mentioned at the beginning of the chapter, this particular finding is based on self-reported data from all four School Mathematics Leaders during their interviews. However, it was also evident in comments made in the survey. Case study and survey data (52%) confirmed that School Mathematics Leaders nominated working with teachers in the classroom as a means of support. This finding is consistent with a number of other studies that focused on working alongside teachers as an opportunity to learn (Darling-Hammond & McLaughlin, 1995; Gibbons, 2012; Gibbons & Cobb, 2017; Gibbons et al., 2017; Hunter et al., 2016; Osborn & Black, 1994; Putnam & Borko, 2000; Roth & McRobbie, 1999; West, 2017).

Learning to teach mathematics requires support and repeated opportunities for teachers to practise in schools. While most teachers display characteristics of effective practice, the key to making a difference is building on these strengths through extensive learning opportunities (Faragher & Clarke, 2014). Working alongside teachers in the classroom is one way that School Mathematics Leaders, as "proficient and experienced teachers of mathematics" (Hunter et al., 2016, p. 61), can provide professional support. It should be noted that the terms working alongside, and co-teaching, are often used interchangeably and describe similar practice. For the purposes of this study, the term *working alongside* teachers is used to describe co-participation in practice with "a more experienced other" (Bourdieu, 1992, as cited in Roth & McRobbie, 1999, p. 514), who applies actions, assurance, reassurance and feedback *in-situation,* directly to the case at hand, in an attempt to facilitate mastery of "the fundamental principles of practice" (p. 514).

All four School Mathematics Leaders involved in the case studies self-reported that they worked alongside teachers teaching mathematics at some stage. As circumstances changed, so too did their opportunities to work with teachers in classrooms. This practice was one way that the School Mathematics Leaders catered for individual teacher needs as they supported them to learn. Practices included either team-teaching, coaching, modelling instruction, observing and providing feedback, or taking small instructional groups during the lesson as the teacher and School Mathematics Leader taught together.

Working alongside teachers in the classroom teaching mathematics, provided an opportunity for the School Mathematics Leaders to support teachers during instruction, with ongoing job-embedded assistance from a more accomplished colleague. This practice allowed both the School Mathematics Leader and the teacher to experience the lesson, then to engage in reflective practice. Similar actions were also described by others in their work (Eden, 2018; Gibbons, 2012; Hunter et al., 2016).

The practice of School Mathematics Leaders working alongside teachers has the potential to provide a range of rich experiences, and powerful learning opportunities for teachers to improve their practice. These findings are consistent with those of Lave and Wenger (1991) who made the point that learning occurs through participation in practice with a more knowledgeable other, and gradually leads to the development of knowledge, skills and discourse as part of a member of a community of practice. While the value of working alongside teachers afforded opportunities for teacher learning, the issue is that it was not consistent, and the opportunity was not available to all teachers who would benefit from this practice or wanted to be involved. Despite the advantages, working alongside teachers in their classrooms consistently was not always possible due to organisational structures such as timetabling, the School Mathematics Leaders' classroom teaching responsibilities and the fact that there was a degree of choice for teachers and an element of risk associated with this approach.

7.5.1 Challenge, trust and risk.

Working alongside teachers in the classroom allowed School Mathematics Leaders to observe teacher practice, identify particular goals, and build trust relationships with the teacher. The School Mathematics Leaders reported that they were able to provide 'in the moment' and in context comments and exchanges related to aspects of the teaching or student strategies and responses. Similar opportunities that allowed exchanges between the teacher and the School Mathematics Leader were also documented by Hunter and colleagues (2016). This 'moment-by-moment' decision-making when choices present themselves is also reflective of the work of Anthony and Walshaw (2009). While the approach to supporting learning was valued by many teachers in this study, the issue here is that for learning to occur there needs to be challenge, and challenge involves trust (Timperley, 2008). Opportunities to learn and make changes were also found to involve an element of risk (Eden, 2018).

The opportunity for in classroom teaching support was available at all of the schools involved in the case studies to some extent, although not an expectation at two of the schools. As well, not all teachers were willing to open themselves up to the risk of working alongside their School Mathematics Leader and be involved. For example, teachers at one school were able to choose how the School Mathematics Leader supported them in their classroom, which allowed a degree of choice. While at another school, support was only provided when teachers asked for support or expressed a need. Teachers who were reluctant may have feared exposing weaknesses in practice. Before teachers will take on that risk of working alongside the School Mathematics Leader, they need to trust that their efforts to change their practice will be supported. A similar conclusion was reached by Timperley (2008). This study found that many teachers had the opportunity to work alongside School Mathematics Leaders and were willing to take this perceived risk.

7.5.2 Linking planning to practice.

An additional advantage of working alongside teachers in their classrooms, was that the School Mathematics Leaders were able to observe what mathematics was being taught across the school, and the pedagogical approaches teachers chose. Working in classrooms also allowed for more targeted support during planning, when experiences and observations came up in discussions with teams, and suggestions were made of lesson ideas that suited specific student needs. The School Mathematics Leaders were able to link planning to practice and see how the mathematics lessons transferred to the classroom as a result of observations of teachers and students. This approach provided a further opportunity for School Mathematics Leaders to support individual teachers to develop their mathematical knowledge for teaching.

7.5.3 Learning through professional conversations.

Working alongside teachers also provided a starting point for conversations about teacher practice and student learning. Engaging in conversations about suitable tasks, teaching strategies, and student learning ‘in the moment’, can be far more effective than waiting until the lesson is over. The follow-up conversations with teachers after the lessons were also valuable, because they were based on what the School Mathematics Leader and the teacher had both experienced in the classroom. Grounding conversations in the experience, discussing what took place, and possibilities for improving the lesson resonated with the findings of Gibbons, (2012) and Gibbons, Kazemi and Lewis (2017). Making the most of timely opportunities, was more valuable when the learning was in context and based on teacher interests and questions.

However, there were several constraints that affected the degree of effectiveness of the conversations. Finding time in the busyness of the classroom, teachers' willingness to be involved, the level of trust in the relationship, as well as the feeling of challenge during these interactions, was confronting. A similar point was made by Little (1990) in her work on teacher collaboration. While each School Mathematics Leader in this study continued to work on building positive relationships with the teachers in their school, the extent of effectiveness of the conversations to support teachers' ongoing learning was very much dependent on these conditions. Teacher learning was further supported based on what the teachers and School Mathematics Leaders had experienced, identified, discussed and acknowledged as effective practice.

7.5.4 Reflective practice.

As the School Mathematics Leaders taught alongside teachers, they were able to take advantage of 'in the moment' opportunities to support teacher learning. Reflective practice allowed shared discourse around aspects of the mathematics lesson and an opportunity for teachers to engage in critical reflection in a supportive environment (Hunter et al., 2016). Reflective practice also created opportunities for change. Change occurs through "reflection and enactment" (Clarke & Hollingsworth, 2002, p. 950), and in this case, teachers were able to reflect on their practice and make appropriate changes with the support of the School Mathematics Leaders working alongside them.

Findings that answered research question one, have been discussed in the first section of this chapter. Ways in which School Mathematics Leaders supported teacher learning included supporting teachers' mathematics planning, working in professional learning teams, developing constructive relationships, engaging in ongoing professional learning and working alongside teachers in classrooms.

Next findings will be discussed in relation to the second research question that framed this study.

Research Question 2: What challenges and successes do School Mathematics Leaders report when supporting primary teachers' professional learning?

While each of the findings could be interpreted as a challenge, they could also be viewed in terms of their success. Two of the key findings that emerged from further analysis showed that:

1. The School Mathematics Leaders' personal qualities contributed to teacher support; and

2. Managing and prioritising time when working with teachers impacted on support provided.

To answer the second research question, these findings will be discussed in terms of both the challenges and successes reported by the School Mathematics Leaders.

7.6 Personal Qualities Exhibited by the School Mathematics Leaders

The School Mathematics Leaders exhibited a variety of personal qualities, many of which were similar. These qualities were found to be important in relation to mathematics leadership. It should also be noted that the terms confidence and self-confidence have been used interchangeably throughout, as according to the Oxford Dictionary of English (2010) there is only a very subtle difference between the two. The Oxford Dictionary of English defined *confidence* as "a belief and an assurance in one's own abilities (self-confidence) or the abilities of another", as opposed to *self-confidence* which is a "belief or assurance in oneself, trusting one's abilities, judgements, or decisions, either in general or in relation to a specific situation or activity. Also called self-assurance".

7.6.1 School Mathematics Leaders' confidence.

A major finding from this study was that the School Mathematics Leaders' level of confidence in their ability to access the necessary knowledge and skills influenced how they led mathematics. The issue here is that some of the School Mathematics Leaders in this study indicated that they were not confident in leading mathematics. In other words, they believed they did not possess the knowledge and skills they felt were important. Of the School Mathematics Leaders (n=56) who responded to the survey, 20 (36%) indicated some form of insecurity or uncertainty in their role. It could be argued that an effective School Mathematics Leader needs a certain degree of confidence or self-assurance to make decisions and choices based on the needs of teachers and students in their schools.

The level of confidence displayed by School Mathematics Leaders was a challenge previously described in the literature by Millett and Johnson (2000). The mathematics leadership role is complex in nature, combines many responsibilities, and has many demands and tensions associated with it, also referred to in previous studies by Millet (1998) and Cheeseman and Clarke (2005, 2006). Findings from the survey data and case studies highlighted some of the demands and tensions experienced by School Mathematics Leaders in this study. Described as challenges the responses included:

- Developing credibility as a leader;
- An unclear job description;
- Lack of experience, training and expertise;
- Closed doors and barriers;
- Poor mentors in the past;
- Lack of communication with the principal in relation to the role;
- Coming in new to a school and establishing themselves as a leader;
- Building relationships with teachers and overcoming resistance;
- Being average at mathematics and not receiving feedback on their own teaching;
- Having enough access to research on latest best practices;
- Being young and thinking more experienced teachers will already know the skills;
- Strategies to support the School Mathematics Leader as a coach/mentor and knowing what to do as a leader; and
- Being worried they were not meeting expectations.

Undoubtedly these tensions and concerns expressed by the School Mathematics Leaders impacted not only on how they led mathematics in their schools, but how effective they were in supporting teachers. Although it was not possible to know how, or if, all the School Mathematics Leaders overcame these challenges, it is possible to infer from the comments made by the four leaders involved in the case studies, that experience over time made a difference. These particular School Mathematics Leaders also believed that as they gained more experience, they were able to overcome many of their initial challenges and improve their ability to lead.

Judging on initial impressions, each School Mathematics Leader that was observed in the case studies appeared on the surface to be self-assured and outgoing, with an extensive knowledge of effective mathematics teaching and learning practices. Although, during observations there were occasions when the School Mathematics Leaders' self-confidence waivered, the fact that all four agreed to be part of this study indicated a sense of confidence. The School Mathematics Leaders' willingness to be observed and interviewed about how they supported teachers professional learning in their schools, also demonstrated a certain self-confidence. The level of self-confidence the School Mathematics Leaders possessed impacted on the decisions they made when working with teachers. The self-confidence School Mathematics Leaders had was apparent during the observations that were undertaken for this study.

One of the School Mathematics Leaders involved in the case study reported that initially, one of her biggest challenges was "developing credibility as a leader." This would indicate that this School Mathematics Leader felt there were times when staff did not see her as a leader in her school. While another pointed out that "it has been hard to build my own capacity while trying to build others." These concerns may have been contributing factors as to why these School Mathematics Leaders consistently engaged in further learning. Engaging in professional learning not only built the School Mathematics Leaders' knowledge for teaching mathematics, and their ability to support teachers, but also contributed to building their self-confidence and self-esteem. This was an important finding in this study. The mathematical knowledge gained by School Mathematics Leaders gave them an inner confidence and self-awareness that they could support teachers, based on their knowledge, skills, experience, and their positive disposition towards improving mathematics teaching and learning.

When the four School Mathematics Leaders involved in the case studies reflected on areas of success in leading mathematics in their schools, they spoke about how they had facilitated or participated in effective planning practices and professional learning team meetings. Each School Mathematics Leader spoke about how they had co-ordinated and presented professional learning and continued to support teachers in a multitude of ways. It was evident that all of the School Mathematics Leaders had made a difference to mathematics planning in some way. Each School Mathematics Leader instigated several major achievements, such as improved planning practices, more frequent use of quality tasks and consistent use of assessment data for planning.

Gaining the support of the school principal and working towards a shared purpose and shared goals also made a difference to the School Mathematics Leaders in terms of confidence. The work of the School Mathematics Leader was integral to the success of the mathematics program in schools and the support it provided for teachers. Although confidence made a difference, many other personal qualities also influenced the work of the School Mathematics Leaders.

7.6.2 Additional personal qualities of the School Mathematics Leaders.

Throughout this study it was obvious that each School Mathematics Leader involved in the case studies exhibited a large degree of enthusiasm, passion, and dedication for teaching and leading mathematics. While in the survey and interview responses the School Mathematics Leaders pointed out many challenges they had experienced, including staffing and principal changes, resourcing limits and school priorities, they also suggested that they gained a sense of achievement with the success of certain projects. The School Mathematics Leaders remained optimistic, enthusiastic, and hopeful their circumstances would improve. Leading with energy, enthusiasm and hope were personal characteristics also found by Fullan (2001, 2020) to have contributed towards effective leadership.

Leading mathematics also required a large commitment in terms of time which was an ongoing challenge. Much of the work completed by the School Mathematics Leaders involved spending many hours of personal time fulfilling the responsibilities. To continue to support teachers, the School Mathematics Leaders needed to be available, reliable, open-minded and empathetic to others, as teachers often sought the advice and support of the School Mathematics Leaders at various times throughout the day. Integrity, patience, and honesty were also desirable characteristics of the School Mathematics Leaders as they endeavoured to achieve success in supporting teachers to learn and grow. These qualities were consistent with the findings of Hunter and colleagues (2016) in their work with mathematics mentors.

In terms of success, each School Mathematics Leader expressed a belief that their leadership skills and their increased mathematical knowledge for teaching had been enhanced over time. The School Mathematics Leaders' improved knowledge and confidence impacted positively on their ability to support teachers in their schools.

However, it was evident that much leadership practice was incidental in a quiet, subtle way. To "lead quietly" in the words of Badacaco (2002) is a desirable characteristic that was reminiscent of the work of two of the School Mathematics Leaders in particular. These two School Mathematics Leaders were not high-profile leaders, but rather individuals who worked consistently to make a difference in their schools, who led with humility and "intense professional will" (Collins, 2001, p. 68). As School Mathematics Leaders, they led with courage and conviction, and a belief that they could really make a difference to improving mathematics teaching and learning in their schools.

While many of the personal qualities mentioned were not immediately obvious, or in the words of Fullan were "below the surface" (2020, p. 8), when it comes to leading mathematics, it is important to appreciate their significance as essential characteristics of effective School Mathematics Leaders.

7.7 The Challenge of Managing and Prioritising Time

Time constraints related to the School Mathematics Leader role was one of the biggest challenges reported in this study. Just over a half (53%) of the 56 School Mathematics Leaders who responded to the survey identified time constraints in relation to implementation of their role. While more than half (68%) of the School Mathematics Leaders had the added responsibility of teaching a classroom as well as leading mathematics. Time to enact the School Mathematics Leadership role has previously been reported as an issue. This study found that adequate time needed to be provided for School Mathematics Leaders to support teachers' professional learning. Other researchers (Cheeseman & Clarke, 2006; Millett & Johnson, 2000; Sullivan, 2011) also found that sufficient time was needed to lead mathematics in schools.

While there were differences in the amount of time allocated to mathematics leadership across schools in this study, this was usually based on funding allocations. Schools that valued the role provided the funding. This point was also made by Jorgensen (2016) as a result of her work that explored successful numeracy practices. Although it was unusual for a School Mathematics Leader in Victoria to work full-time out of the classroom, time was made available for one School Mathematics Leader in this study to do this. Adequate time enabled this particular School Mathematics Leader to provide extensive support to the teachers at her school. This School Mathematics Leader was able to attend all Year level team planning, professional learning team meetings, as well as work alongside teachers in their classrooms. Whereas another School Mathematics Leader suggested that lack of funding to provide for time release, was an issue at her school that impacted on the extent to which she could work with teachers in their classrooms, support collaborative team planning, and adequately fulfil the expectations of the role. This finding is not something new but continues to be an issue.

Although time was needed to meet and plan with teams, to work with students and teachers, and to lead mathematics in schools, being creative with the time available was a possible solution. Fullan (1995) also suggested that there were possible ways to use time differently. Some schools achieved success by making better use of time and changes to the organisation of traditional programs. These schools adjusted the school day, or made changes to the way programs and meetings were run and the level of expectation. In this study, providing support in the classroom where teachers were able to learn from the School Mathematics Leader was one way of making the most of time as a learning opportunity.

However, the issue here is that if School Mathematics Leaders are to support teachers professional learning and make a difference to student outcomes, time is needed. Allocating appropriate funds to provide time release for the role of the School Mathematics Leader was also a recommendation made by Cheeseman and Clarke (2006), and not a lot has changed.

Another key finding will be discussed in relation to the third research question that framed this study.

> *Research Question 3:* What challenges and successes do School Mathematics Leaders experience as they build professional learning communities?

While professional learning communities are one of the most promising strategies for improving student learning (Du Four et al., 2010), how School Mathematics Leaders maximise their potential as an opportunity to support teachers to learn is important in this study. The third research question is situated in the bigger picture of the school as a professional learning community as opposed to the individual teams that comprise it. Collaborative teams that work together to achieve common goals are an essential part of the learning community.

Working in a professional learning community brings with it many challenges but also successes in terms of what is achieved. The survey and case studies identified several challenges and successes experienced by the School Mathematics Leaders as they attempted to work with teachers to build professional learning communities and work as part of collaborative teams in their schools. A key finding that emerged from analysis of the data showed that:

1. Building and developing professional learning communities enhanced the School Mathematics Leaders' ability to support teacher learning.

In answer to the third research question much has already been written in responding to the previous two research questions. However, it was necessary to expand on a few key points in the following section. Not only did the School Mathematics Leaders in this study support teacher learning in ways that have already been discussed, but they also worked as change agents, pushing for changes in order to make a difference and bring about continued improvement in mathematics (Fullan, 1993). This improvement involved encouraging teachers to work collaboratively in an ongoing process of inquiry and action research, which can lead to student and teacher growth (Du Four, 2004).

7.8 Building Collaborative Professional Learning Communities

Each School Mathematics Leader in this study encouraged and supported teachers to learn by:

- Jointly planning mathematics programs;
- Actively participating in professional learning team meetings;
- Attending and/or facilitating meetings;
- Reviewing student assessment data;
- Modelling lessons;
- Team teaching in classrooms; and
- Observing and reflecting on instruction.

As leaders acting purposefully, the School Mathematics Leaders saw their role as supporting teachers to learn. Although working with groups or one-on-one with teachers was a critical component of the School Mathematics Leaders work, it was also necessary to think of the role more broadly. In this study, it was found that the School Mathematics Leader role extended to fostering development of school-wide professional learning communities. Professional learning communities that focused on curriculum, subject knowledge, and student learning with a shared vision and a sense of purpose, were found to be more effective. Teacher learning took place in meaningful contexts and was enhanced by developing communities of practice, where teachers participated in shared experiences and discourse around student data and learning (Bransford et al., 2000; Lave & Wenger, 1991).

Working in professional learning communities with access to expertise in the form of a School Mathematics Leader, who provided continuous job-embedded support, was found to be an important factor in encouraging teachers to learn. Findings from several other studies (Coburn & Russell, 2008; Gibbons, 2012; Johnson & Scull, 1999; McLaughlin & Talbert, 2001; Talbert, 2009) contributed to the body of increasing evidence that supports this idea. Structures that promoted a collaborative culture, where teachers worked together, supported by a School Mathematics Leader, helped build an effective professional learning community. This idea is consistent with the work of Du Four (2004) who also found there is strong evidence that working collectively characterises best practice, promotes deep learning, and leads to student improvement. The scope of the present research did not enable an investigation of this claim, but future research would possibly shed more light on this point.

7.8.1 Reported challenges related to building professional learning communities.

In this study, there were many challenges faced by each School Mathematics Leader as they attempted to build professional learning communities. Four reported challenges will be outlined in the following section.

7.8.1.1 Embedding the professional learning community process into the school culture.

It was apparent that each School Mathematics Leader worked to different extents to improve instruction as part of their leadership role, by building a professional learning community focused on effective mathematics teaching and learning. Opportunities for School Mathematics Leaders to work with teachers in professional learning communities were influenced by several factors which impacted on the effectiveness of the support provided. In several cases, the challenge was to embed the professional learning community process that included team collaboration, into the culture of the school (Du Four, 2004), and for teachers to see the value of spending time together, to engage in an on-going cycle of learning, observation, and review of student data and work samples (AITSL, 2011, 2017; Du Four et al., 2010). Despite success in some schools in this study, this appeared to be an on-going issue in two other schools which leads to the next point.

7.8.1.2 Belief in the benefits of working together in teams.

Teacher willingness and belief in the benefits of working together in teams as opposed to working in isolation (Du Four, 2004; Fullan, 1993) was a further challenge. Despite strong evidence that working collaboratively characterises best practice (Du Four, 2004), teachers in two of the schools continued to work in isolation. When teachers work collaboratively in professional learning teams, for some there is also a fear of being exposed by their colleagues and principals as ineffective (Du Four et al., 2010). Fear experienced by a teacher in this sense was obvious in one particular school during observation of a moderation meeting and is illustrated in Section 5.3.1.2. Being exposed and vulnerable is a risk that some teachers need to overcome if they are to benefit from working in a team. Teachers who work in effective teams learn to acknowledge weakness, mistakes, and the need for help, and are willing to learn from and support one another. The support provided by School Mathematics Leaders made a difference. For a team to function as a collaborative team it is important to establish trust between members of the team, engage in open dialogue, and clarify expectations of one another (Du Four et al., 2010). These conditions were evident as a part of the practice of several School Mathematics Leaders.

7.8.1.3 Prioritising time to meet.

In particular, the four School Mathematics Leaders involved in the case studies encouraged teachers to work together in collaborative teams, as they believed this contributed to teacher learning. Two of the four School Mathematics Leaders shared the opportunity to plan collaboratively in teams with teachers. Despite the fact that the School Mathematics Leaders who did not work with teams to plan, strongly advocated for this approach and the known advantages of collaborative team planning, the schools in which they worked did not prioritise this practise or allow time for this to occur during the school day. Therefore, the challenge was to find dedicated meeting time. Final decisions regarding organisational structures that support collaboration in schools' rest with the school principal. A fundamental step that principals can take as leaders is to facilitate teacher learning, embed collaboration, and provide time for these planning meetings to occur (Du Four et al., 2010).

7.8.1.4 Ensuring the professional learning communities are effective and productive.

Collaboration in professional learning communities is a powerful process. The collaboration process that occurred when teachers worked together with a School Mathematics Leader to review and analyse student work, in an attempt to improve their classroom practice, had the potential to lead to higher levels of student achievement (Du Four, 2004). However, while many teachers were given time for collaboration, this was at times ineffective and unproductive. Simply putting teachers in groups does not ensure a productive, positive experience. While some teams of teachers appeared to be collaborating, the important question was, "What [were] … they collaborating about?" (Du Four et al., 2010, p. 119). Improvement can only be accomplished if teachers are engaged in the right work related to what students need to learn (Du Four et al., 2010). Creating the conditions for this to occur was a further challenge for the School Mathematics Leaders. Guiding teams to focus on the goal of student achievement as well as the creation of team norms, helped clarify expectations in relation to procedures, responsibilities and relationships. Du Four and colleagues (2010) also made this point and suggested that it increased the likelihood of success, although the norms needed to be followed in a consistent manner.

7.9.1 Reported successes related to building professional learning communities.

Teams of teachers who work together are one of the most powerful structures for school improvement. Engaging in collaboration on issues related to student learning brings teachers together in an organised way to achieve a collective purpose that cannot be achieved by working alone (Du Four et al., 2010). Teachers who work collaboratively in professional learning communities, reflect on their practice, examine evidence, and make changes to improve teaching and learning to benefit students, (McLaughlin & Talbert, 2006). School Mathematics Leaders from schools that created opportunities for teachers to be part of a professional learning community, reported various successes experienced by teachers. Three points will be elaborated in the following sections of this thesis.

7.9.1.1 Benefits of collective responsibility.

The School Mathematics Leaders in this study believed in, and promoted, the benefits of working in teams. While teachers found working in professional learning teams at times challenging, a point also made by Johnson and Scull (1999), they also experienced many successes. Successful collective work saved on preparation time and had the potential to be more effective and efficient, while working collectively created more meaningful learning opportunities for all students (Johnson & Scull, 1999). In addition, collective professionalism cultivated individual and collective efficacy amongst teachers (Fullan & Hargreaves, 2016). When teams of teachers worked together using everyday work-related learning opportunities and took responsibility for the learning of all students in a professional learning community, learning gains for both teachers and the students were more likely to occur (Johnson & Scull, 1999).

7.9.1.2 Becoming change agents.

In terms of success, the School Mathematics Leaders acted as agents of cultural change, as they fostered norms of collaboration. Establishing and maintaining professional learning communities is an important part of mathematics leadership. The School Mathematics Leader role in a community of learners is linked to building teacher capacity and developing a collaborative culture that results in sustained improvement. Ongoing improvement requires that teachers and leaders work together and act as change agents with moral purpose. This idea is consistent with the work of Fullan (1993, 2020), who believed that moral purpose and change agentry were inter-related and worked together effectively to get “the right things done” (1993, p. 18). Collaboration builds greater change capacity, and without collaborative skills and relationships, it is not possible to continue to learn (Fullan, 1993). Success is more likely when a combination of change agents, including teachers, principals, and School Mathematics Leaders, work together with a focus on improvement. All three groups working together are more likely to bring about deep change. This point resonates with the work of Fullan and Knight, (2011), and Johnson and Scull (1999), who suggested that effective teams include all teachers as change agents.

7.9.1.3 Opportunities for collegial support.

A further success resulted as teams of teachers worked collaboratively with their School Mathematics Leaders to support less experienced teachers through the sharing of knowledge and resources. Working in a professional learning community provided opportunities for collegial support, as teachers developed an understanding of effective mathematics teaching. Being a member of a team also provided support as teachers used evidence to inform their teaching practice. Working in a professional learning community provided opportunities for teachers to develop their professional knowledge and analyse evidence, not only of student learning, but also their own practice. The benefits and the impact of a professional learning community are substantial, as they inform and guide effective teaching, and indicate what changes need to be made, a view also held by Timperley (2010). A regular occurrence in this study, was for teams of teachers to discuss and moderate common assessments. The aim was to share and discuss evidence of student learning and to improve teaching through this collective process. All four School Mathematics Leaders believed in and promoted the benefits of working together in professional learning communities.

In summary, each of the main findings presented in this chapter was discussed in relation to the research questions that framed the study and connected to the literature underpinning the study. The findings identified ways in which primary School Mathematics Leaders supported teachers' professional learning and some of the reported challenges and successes experienced as they led mathematics and contributed towards developing and building professional learning communities. While each School Mathematics Leader believed their role was to facilitate teachers professional learning, despite some challenges, they endeavoured to create the conditions for this to occur collectively as a community.

The final chapter of the thesis presents the conclusion and implications. This includes a summary of the findings with recommendations, limitations of the research, implications for practice and suggestions for further research.

Chapter 8: Conclusion and Recommendations

A summary of the study is presented in this concluding chapter. The major findings which were guided by the research questions will be summarised and some final recommendations will be made. Limitations of the study are acknowledged, and the key implications for schools and principals as well as schools and system leaders are outlined. Finally, the findings inform a list of identified actions of effective School Mathematics Leaders which were found to be part of their practice as they supported teachers' professional learning. These actions are presented, followed by recommendations for further research and a concluding statement.

8.1 Summary of the Study

While it is common in many Australian primary schools for a teacher to take on the role of a subject leader in mathematics, research detailing the ways in which these leaders support classroom teachers of mathematics is scant. This study sought to investigate and identify the ways in which School Mathematics Leaders supported primary teachers' professional learning. Teacher learning was the theoretical lens used to frame and guide the research design and data analysis to capture the complexities of the work of the School Mathematics Leaders. This study drew on the work of Lave and Wenger (1991) who presented a social theory of learning and viewed learning as a characteristic of social practice. A leadership framework (Fullan, 2001) for describing and analysing leadership was also used as the participants were leaders of mathematics in their schools. The purpose of this study was to gain a deeper understanding of the ways in which primary School Mathematics Leaders influenced and built professional learning communities, whilst supporting teacher professional growth. This study also sought to document some of the challenges and successes experienced by the School Mathematics Leaders in their role.

Qualitative research methods were chosen for this study because it enabled exploration of the ways in which School Mathematics Leaders supported teachers' professional learning. This study was interpretative research, as it focused on specific contexts in which School Mathematics Leaders worked and lived and relied "as much as possible on the participants' views of the situation" (Creswell, 2007, p. 20). Therefore, the study was interpretative research using qualitative methods. The qualitative research design was a combination of two types, case study (Merriam, 1998a), together with open coding procedures, which were used for data analysis (Yin, 2016).

The data collection was completed over ten months in two parts. Phase 1 was a survey of School Mathematics Leaders, and Phase 2 consisted of four case studies, which involved observations and interviews of four School Mathematics Leaders. The survey data reported in Chapter 4 provided a context and an overall picture of the nature of the School Mathematics Leader role at the time of the study, including some of the challenges and successes the leaders believed they had experienced. The survey was also a means of selecting participants for the individual case studies. Case study design was selected as the most appropriate method for this research, as it allowed an in-depth investigation of a contemporary phenomenon within its real-life context (Yin, 2009). In this study, the practices of School Mathematics Leaders working in schools was the phenomenon under investigation. Case study made it possible to gain a detailed picture of the experiences of the School Mathematics Leaders as they supported teachers to learn more about the teaching and learning of mathematics.

Although data analysis for this research aligned with a grounded theory approach, for the purposes of this study the five-phased cycle headings proposed by Yin (2016) were used. These five phases of analysis: compiling, disassembling, reassembling, interpreting and concluding provided structure during the analytical phase, and enabled analysis to progress in a methodical manner. The results presented in Chapters 4 and 5 revealed ways in which the School Mathematics Leaders led and supported mathematics in their schools, and factors which influenced the effectiveness of this leadership. As a result of a cross-case analysis, four themes that emerged were described and discussed in Chapter 6. Further interpretation of the findings led to a more complete understanding of the results which were discussed and organised according to the three research questions in Chapter 7. This led to the next level of data analysis in this chapter, the concluding phase (see Appendix N). As a result, the following major findings were identified and summarised, along with a list of identified actions of School Mathematics Leaders who were seen to be effective in their leadership role, as they supported teacher professional learning.

The following findings are important and will contribute to the literature in the field. Evidence gathered from survey data and four case studies reported the importance of mathematics leadership in schools and the support it provided for teachers to learn to be more effective teachers of mathematics. In contrast, the extent to which the School Mathematics Leaders supported teachers to develop their mathematical knowledge for teaching varied, and leaders' approaches differed from school to school, albeit a number of similarities were evident. Particular strengths as leaders and certain personal qualities such as enthusiasm, passion and dedication also made a difference to the support provided by the School Mathematics Leaders when supporting teachers in their schools.

These findings have contributed to knowledge in the field of leadership in mathematics education, about which there has been a paucity of informed research

8.2 Summary of Major Findings and Recommendations

Included in this section is a summary of the major findings that provided answers to the research questions investigated in this study along with a series of recommendations.

Major research question:

> How do School Mathematics Leaders support primary teachers' professional learning?

Subsidiary research questions:

> What challenges and successes do School Mathematics Leaders report when supporting primary teachers' professional learning?
>
> What challenges and successes do School Mathematics Leaders experience as they build professional learning communities?

Each of the research questions along with the related challenges and successes reported by School Mathematics Leaders have been discussed at length in Chapter 7. This summary of the findings will be presented by answering the main research question. Data concerning the sub-questions will be woven into this discussion where appropriate to extend the summary of findings.

8.2.1 Supporting teachers' professional learning in collegial meetings.

This research highlighted the importance of School Mathematics Leaders working with teachers in collegial planning and professional learning team meetings. Working together in a community of practice (Lave & Wenger, 1991) supported teachers to learn more mathematical knowledge for teaching. Survey results indicated that School Mathematics Leaders (36%) believed they provided valuable support in planning meetings, while nearly a third (30%) of the group surveyed felt this was one of their greatest achievements.

The School Mathematics Leaders played a crucial role in both planning and professional learning team meetings in developing teacher knowledge of effective mathematics teaching practices. The School Mathematics Leaders attempted to provide a balance between pressure and support, which differed according to individual needs. In these meetings, effective School Mathematics Leaders: stimulated discussion; encouraged professional reading; developed data literacy; asked probing questions; guided and evaluated mathematics planning; pressed teachers to contribute, extending their knowledge for teaching; and often supported teachers with lesson ideas.

The School Mathematics Leader's mathematical knowledge for teaching and their understanding of how teachers learn supported these potential learning opportunities. Additionally, the School Mathematics Leaders personal qualities, their skills and knowledge, their experience and mathematical expertise, their confidence, and relationship-building strengths were also crucial. School structural arrangements and management decisions also made a difference to the degree of success in supporting teachers' professional learning in collegial meetings. However, it was clear that limited time to meet with teachers and inadequate funding, also reflected in the survey, acted as constraints to initiating and supporting mathematics improvement. While organising meetings on a regular basis in collaborative teams in some schools was not always seen as a priority.

> *Recommendation:* It is recommended that School Mathematics Leaders lead regular meetings where teams of teachers collaborate to plan mathematics teaching and learning opportunities for students, while engaging in ongoing professional learning, and that organisational arrangements enable this to occur.

8.2.2 Supporting teachers' professional learning by developing positive relationships with principals and teachers.

The relationships that existed between teachers and the School Mathematics Leaders in this study, were critical in determining the success of the leadership of mathematics. This key finding confirmed the importance of developing positive professional relationships with teachers and principals in supporting teacher professional learning. Survey results showed that teacher resistance (37%) was a concern for some School Mathematics Leaders in this study. However, effective School Mathematics Leaders build positive relationships and are aware of differences and appreciative of resistance (Fullan, 2001). Just as important was the relationship that existed between each School Mathematics Leader and their principal. The alignment of philosophy and purpose possessed by these two key leaders made a huge difference to the success of mathematics professional learning in the four schools. The professional collaboration impacted the decisions made and the intellectual and emotional support provided to teachers.

When School Mathematics Leaders gained the trust and respect of teachers and the support of the principal, their leadership of mathematics in schools was enhanced. Knowing that there was a high level of relational trust in their relationship and believing they would be supported in their work by the principal, contributed to the School Mathematics Leaders' confidence to make decisions. Effective mathematics leadership required both the principal and the School Mathematics Leader working together towards the same goals. With this in mind, it was the decisions made by the principal related to prioritising school mathematics programs, and managing resources and school priorities, that often impacted on the ways in which School Mathematics Leaders could potentially support teachers professional learning. "Principal leadership that focused on the development of teachers' knowledge and skills, professional community, program coherence, and technical resources" (Fullan, 2002a, p. 1) was at the heart of improving school capacity.

> *Recommendation:* That School Mathematics Leaders and principals work in close collaboration and continue to align practice and leadership to ensure decisions that are made benefit the future direction and needs of the school to embed and sustain effective practice in the teaching and learning of mathematics.

8.2.3 Engaging on ongoing professional learning and knowledge building.

Another significant finding related to the School Mathematics Leaders' passion and enthusiasm for ongoing professional learning. Findings revealed that each of the School Mathematics Leaders involved in the case studies consistently engaged in opportunities for mathematics-related professional learning, through courses, conferences or projects. Many of these courses were completed in the School Mathematics Leaders' own time, and sometimes at their own expense. It could be argued that some School Mathematics Leaders needed to develop their expertise as leaders of mathematics teaching. Comments (36%) in the survey indicated a level of uncertainty experienced by many School Mathematics Leaders, including: the extent of experience and training as a leader, the depth of mathematical knowledge for teaching, and not understanding expectations of their work as mathematics leaders.

However, the School Mathematics Leaders also continued to learn on the job. Learning-by-doing contributed to the School Mathematics Leaders ability to support teachers as they drew upon knowledge and skills acquired in their work. As the School Mathematics Leaders developed strong mathematical knowledge for teaching, being seen as ongoing learners, contributed to establishing their credibility among teachers in their school. This study revealed that the School Mathematics Leaders expertise in mathematics leadership was enhanced as they developed a deeper and broader mathematical knowledge for teaching, combined with a knowledge of effective leadership. A sense of knowing more, contributed to the School Mathematics Leaders' courage, strength and patience as leaders, and their potential to lead and support teachers to learn effectively.

> *Recommendation:* That all School Mathematics Leaders be supported to engage in ongoing professional learning opportunities to deepen their understanding of mathematical knowledge for teaching and effective leadership, to build their capacity to lead and support teachers.

8.2.4 School Mathematics Leaders' personal qualities.

Many of the School Mathematics Leaders personal qualities were similar, despite differences in the ways in which they led mathematics. As each School Mathematics Leader expressed how they perceived themselves as mathematics leaders, it was evident that aspects of their teaching philosophy were also similar. Each School Mathematics Leader was driven by a desire to make a difference to the teaching and learning of mathematics. Their passion, motivation, and enthusiasm for mathematics education were obvious when interviewed and observed working with teachers in their schools. Teacher growth, not only in their schools, but in the wider education system was a focus of several of these leaders. Each School Mathematics Leader demonstrated dedication and commitment as they tried to influence teacher growth and teacher change, spending much of their own time completing their own professional learning so they could effectively lead teachers in their schools.

As the School Mathematics Leaders described accounts of their work, it was apparent that through their actions and interactions with colleagues, their capacity and understanding of the most effective ways to lead mathematics evolved. On-going learning contributed to the School Mathematics Leaders level of mathematical knowledge for teaching. Knowing the content and knowing how to teach it (Ball et al., 2008) was important as a leader. Additionally, knowing that the knowledge the School Mathematics

Leaders had gained was backed up by experts in the field of mathematics education and supported by research, contributed to the leader's confidence and self-esteem. Knowing they could draw upon this knowledge gave the School Mathematics Leaders a sense of courage and strength, and a belief that they possessed the necessary skills to lead mathematics in their school. This inner strength or self-assuredness influenced how the School Mathematics Leaders viewed themselves as leaders and was reflected in how they approached and responded to teachers in their teams. A type of reciprocal relationship evolved, where the School Mathematics Leaders who knew their work was valued by teachers and principals felt appreciated and respected, which in turn could increase their self-confidence and their ability to lead. This study found that the most effective School Mathematics Leaders were capable, self-assured and confident in a quiet unassuming way, who had a sense of purpose and motivation. These School Mathematics Leaders acted with a sense of humility and possessed an innate capacity to lead mathematics effectively in their schools.

> *Recommendation:* It is recommended that ongoing programs and support be provided in the form of mentoring and leadership courses, to support School Mathematics Leaders to develop their knowledge, skills and confidence as leaders of mathematics teachers.

8.2.5 Managing and prioritising time.

Time continued to be a dominant challenge which needs to be recognised and acted upon. This was a significant finding based on analysis of the data and results that emerged from both the survey and case studies. Survey results showed that more than half (53%) of the School Mathematics Leaders indicated that limited time to achieve expectations of the role was a key challenge. Of the four School Mathematics Leaders that were involved in the case studies, only one leader agreed she had been allocated enough time to effectively support teachers in her school. While it is possible to be creative with the time available and make adjustments to the school day or the way meetings are run, teachers need support to develop quality mathematics practice. Having access to someone who can support them, is a further catalyst in allocating adequate time to ensure this occurs. To be an effective School Mathematics Leader, time is needed.

> *Recommendation:* That formal time release of the School Mathematics Leader's time fraction be evenly proportioned to allow them to work closely with teachers in classrooms; provide necessary curriculum support for teachers in planning and

professional learning team meetings; and to allow for organisational and managerial duties.

8.2.6 Supporting teachers' professional learning by building learning communities.

Throughout this study each School Mathematics Leader consistently contributed towards building professional learning communities that enhanced teacher learning and teacher growth. Reported challenges and successes experienced by the School Mathematics Leaders as they built professional learning communities have been written about in detail in the previous chapter. The building of professional learning communities was achieved to differing degrees, depending on the effectiveness of the School Mathematics Leader, as well as the school context. Each School Mathematics Leader shared and discussed pedagogy and curriculum as they encouraged participation in learning communities. In some cases, the School Mathematics Leaders facilitated planning and professional learning team meetings, while others gathered and discussed evidence of student learning and developed strategies and ideas for implementation, then analysed the impact and effectiveness of these lessons. All School Mathematics Leaders contributed in some way towards building professional learning communities though their interactions and engagement in a whole school community of practice (Lave & Wenger, 1991). Teacher learning, teacher change, and teacher growth were inevitable consequences of participation in the learning community and were front and centre of the strategic thinking of the School Mathematics Leaders.

Recommendation: It is recommended that opportunities be created to enable teams of teachers to meet regularly in professional learning teams, with a School Mathematics Leader, for the purposes of professional learning in mathematics with a specific focus on improving teacher's mathematical knowledge for teaching.

8.2.7 Supporting teachers' professional learning in classrooms.

An important finding that emerged from this study was the practice of School Mathematics Leaders working alongside teachers in their classrooms, and the potential it provided as a way of supporting teachers to learn to teach mathematics. While this was evident in the case studies, the survey data also confirmed this finding. Just over a half (52%) of the 56 School Mathematics Leaders who responded to the survey indicated that they worked with teachers in their classrooms in some capacity. Described by the School Mathematics Leaders as particularly valuable, working alongside teachers in a classroom setting for example, by coaching, mentoring or modelling, provided further opportunities for teachers to build their mathematical knowledge for teaching (Ball et al., 2008). Engaging in and experiencing joint practice such as team teaching was a far more effective way of supporting teachers to learn, as opposed to learning through spoken and written language alone. Learning occurred as part of social practice where teachers participated in shared experiences (Lave & Wenger, 1991).

School Mathematics Leaders working alongside teachers is an effective way of supporting teachers in their daily practice, despite several challenges that were associated with creating such opportunities, including elements of risk and trust in the relationships. Based on their self-reported observations, both teachers and the School Mathematics Leaders were able to respond to situations spontaneously as events unfolded naturally in the busyness of the classroom. School Mathematics Leaders in the case studies reported the resulting professional conversations were important in promoting reflective practice and led to appropriate pedagogical changes. While the shared experiences created valuable opportunities for teachers to access a more experienced person in the classroom, with a high level of knowledge and understanding of effective mathematics teaching and learning. When working alongside teachers, the School Mathematics Leaders reported being able to call upon their expert knowledge and ability to notice, their interpretations of the situations, and understanding of effective teaching and learning of mathematics when supporting teachers in their mathematics classrooms.

> *Recommendation:* It is recommended that as a priority, School Mathematics Leaders, as the more experienced colleague, be provided regular opportunities to work alongside teachers in their classrooms to assist with the development of effective pedagogical practices, and to offer support and guidance in a respectful partnership.

In the next section, possible limitations of the study will be discussed.

8.3 Limitations of the Research

A qualitative case study was used to investigate how School Mathematics Leaders supported teacher professional learning. In this section, possible limitations that may have attributed to the results are identified, highlighted and discussed. These included: the bounded context in which observations occurred; issues related to my role as a School Mathematics Leader; the number of participants in the case studies; and the impact of the selection process of participants in the case studies.

First, observations as part of the research focussed on four School Mathematics Leaders and teachers in professional learning team and planning meetings. The fact that the four case studies focused on one confined or bounded aspect of the very complex nature of the School Mathematics Leader's work was a limitation. In hindsight it would also have been beneficial to focus on School Mathematics Leaders working in other situations, such as with teachers in their classrooms. While the actual observations were limited to meetings, it did allow me to study one element of the work of the School Mathematics Leaders in-depth. I was able to examine in detail the School Mathematics Leaders actions and interactions with the participants, consider the potential for learning generated in these meetings and view the specific ways that School Mathematics Leaders supported teacher professional learning.

Second, having worked as a School Mathematics Leader and a *Primary Mathematics Specialist* teacher myself, I have a detailed appreciation of mathematics leadership. I bring experience and knowledge and understand the complexities of leading mathematics in terms of my personal successes and challenges. This might be seen as a limitation or an advantage. This may have influenced the questions I asked in the survey and in the interviews, and the resulting data analysis. While I acknowledge that this could be so, I believe the evidence speaks for itself and that my perspective is balanced by the literature. It was my intention to gain further insights into the actions of School Mathematics Leaders and see the leadership of mathematics from the perspective of other School Mathematics Leaders in school settings other than my own, while keeping in mind not to judge, but to present the evidence and let it stand on its own merit.

Third, although 56 School Mathematics Leaders responded to the initial survey, the in-depth case studies involved only four School Mathematics Leaders. This was recommended as a manageable number by the university review panel at my first candidature meeting. To involve a larger number of participants would possibly have been difficult in the time frame and constraints of reporting the study. However, although this data revealed a great deal about the actions and interactions of School Mathematics Leaders in meetings in their schools, a larger number of participants, including more males and teachers from non-government schools would have provided greater breadth. As well, looking at School Mathematics Leaders from a wider area across Victoria or various regions across Australia might have extended the findings of results.

Last, the School Mathematics Leaders selected for the case studies were initially recommended by experts in the field of mathematics education and may not be typical of all School Mathematics Leaders. It was my intention to select participants from the respondents to the survey who had established themselves in their school, were able to draw upon a number of years of experience, and who demonstrated an understanding of leading mathematics. Known as purposeful sampling, this was to ensure that the School Mathematics Leaders studied would provide "*information rich"* (Yin, 2016, p. 93, emphasis in original) data. Equally important was the inclusion of a range of School Mathematics Leaders who might offer a broad range of information and some contrary evidence or views, in some cases, so as not to give the appearance of bias in the study (Yin, 2016). This might also have influenced the results, as these School Mathematics Leaders had already established themselves in their schools and believed in the value of mathematics leadership. The fact that the School Mathematics Leaders agreed to be participants in further research might have also influenced the results, as they volunteered to be observed and interviewed. This is something that not all School Mathematics Leaders had the time to do or were prepared to do. Of the 56 respondents to the survey, 13 School Mathematics Leaders were contacted to be part of the further study, four declined due to other competing demands on their time or for personal reasons, while five did not respond at all to the request.

8.3.1 Limitations and strengths of the case study.

Finally, limitations and strengths are present in all research, including case study research. The strength of case study is that it deals with individual cases in the actual context. It is a means of investigating a contemporary phenomenon within its real-life context (Merriam, 1998a). In this study, using a case study approach allowed accounts of the School Mathematics Leaders' work to be told through the analysis of a variety of data.

However, as the researcher was the primary person collecting and analysing the data, this could be viewed as a possible limitation of the case study approach. Care was taken not to over exaggerate or simplify the situation and a range of data collection methods were used that allowed for triangulation, including a survey, interviews, observations, prompted written reflections and other anecdotal evidence, which contributed to the strength of the data obtained and reported. Prior experience as a School Mathematics Leader could also be seen as a strength rather than a limitation as this allowed the researcher to capture more of the complexities of the experiences (Patton, 1982). However, at the same time throughout this study I was also aware of bias and the fact that this could affect the final product (Merriam, 1998a).

8.4 Implications and Recommendations for Practice

There is significant evidence of the need for school-based leadership in mathematics. This study highlighted the important role School Mathematics Leaders played in developing a whole school approach to the teaching and learning of mathematics while supporting teachers in the enactment of effective practices. A number of implications resulted from this study and are linked to decisions made at the school and system level in relation to how School Mathematics Leaders could best support teachers to learn to teach mathematics. Implications that arose from this study are:

8.4.1 Key implications and recommendations for schools and principals.

- *School wide improvement in mathematics requires School Mathematics Leaders, teachers and principals to work in close alignment and to link decisions they make to their core purpose.* It is critical that all parties work closely together to encourage coherence in approach and programs, with the aim of improving student learning in mathematics.
- *Ongoing support and access to professional learning is critical for School Mathematics Leaders*. To ensure School Mathematics Leaders provide informed support of the latest research approaches to teachers and leadership, it is important they have the opportunity to engage in regular professional learning and support from external mentors. Expanding their knowledge of mathematics and mathematical pedagogy as well as educational leadership enables School Mathematics Leaders to support teachers more effectively.
- *Staff turnover and change impact on the support School Mathematics Leaders provide.* To ensure momentum is sustained as School Mathematics Leaders

build teacher expertise, creating and maintaining routine structures and ensuring documentation is in place would limit the negative impact of staff changes.

- *Decisions related to how schools allocate roles and responsibilities using available personal in the staffing structure, require consideration of teacher expertise in mathematics.* Valuing teacher expertise has the potential to make a difference in maximising effects on teachers and students. When decisions are made in relation to staffing and structures, it is important to optimise and prioritise teachers who have the most potential to succeed in the role, and ensure the complexities and structures within the school do not get in the way.
- *Collaboration in professional learning communities is a powerful process.* It is important that teams of teachers spend time together, whether planning mathematics lessons or analysing and discussing student work samples, with School Mathematics Leaders in professional learning communities, to enhance the knowledge and skills of teachers, and in turn benefit the students they teach.
- *Investment impacts on effectiveness of the School Mathematics Leader role.* To fully support teacher development and improved learning outcomes for students in mathematics, the School Mathematics Leader role should be adequately funded, on-going and built into the staffing profile of the school.
- *Time impacts on the extent of support for teachers to learn.* As a priority, adequate time must be provided to allow School Mathematics Leaders the opportunity to support teachers to develop quality practice. Time for collaboration with teams, time to work with teachers in classrooms, and time to engage the whole school community to help to support teachers to become knowledgeable, skilled and confident in the teaching of mathematics.

8.4.2 Key implications and recommendations for systems and government.

- *The education sector/system has a responsibility to continue to prioritise the focus on improving mathematics teaching and learning.* Creating the optimum conditions for this to occur in our schools is critical for our country’s future.
- *Limited investment impacts on the effectiveness of initiatives and projects.* It is important that governments fund and continue to support successful projects that make a difference to teacher learning and student outcomes in mathematics on an ongoing basis.

- *Partnerships and professional learning networks can be powerful. Schools cannot lead improvement in mathematics by working in isolation.* Connecting with leaders and teachers in other schools, organisations and regions, can make a positive difference through the sharing of common interests, resources and professional learning. Greater alignment can provide new perspectives to the work and necessary support opportunities to allow teams to collaborate across school communities.
- *Systems have a role to play in encouraging effective practices in the teaching of mathematics in schools.* Having access to dedicated School Mathematics Leaders in schools provides necessary support for teachers. However, this study also suggests that governments can encourage effective practices in the teaching of mathematics through ensuring well-designed, thoroughly evaluated and carefully monitored policies and programs, including initiatives such as the *Primary Mathematics Specialists* (DET, 2017a) program are implemented in an on-going basis in schools.
- *Sustained systematic improvement in student learning of mathematics directly depends on the quality of teaching.* This is best supported by dedicated School Mathematics Leaders, working closely with teachers, principals and staff in central or regional offices and governments working in collaboration.
- *Ongoing support and access to professional learning is important for School Mathematics Leaders.* Support provided at the system level through central offices in the form of consultants who can work with School Mathematics Leaders has the potential to develop expertise and build a better understanding of the mathematics program across schools.

8.4.3 A final implication and recommendation.

A final implication and recommendation that resulted from this study into the ways in which School Mathematics Leaders supported teachers to learn that will inform the literature in the field of mathematics education and professional learning is as follows:

> *Specific actions of School Mathematics Leaders have the potential to create substantial learning opportunities for teachers.* Evidence from this study provided important insights into the ways in which the most effective School Mathematics Leaders supported teachers to learn. These actions have been grouped according to themes that resulted from this study and might be considered by current and future

School Mathematics Leaders as they lead mathematics in their schools and reflect on their leadership.

8.4.4 School Mathematics Leader actions that support teacher professional learning.

Informed by the findings and the literature, a list of possible actions that could potentially be part of School Mathematics Leaders' practice in supporting teacher professional learning became apparent. Table 8.1 illustrates a list of actions displayed by effective School Mathematics Leaders in this study.

Table 8.1

School Mathematics Leaders' Actions that Support Teacher Professional Learning

Effective School Mathematics Leaders support teachers' professional learning by …	
Relationships (Fullan, 2001)	Developing constructive working relationships with the principal Developing constructive working relationships with teachers Being aware of teacher differences and Understanding resistance
Planning	Facilitating regular collaborative team planning Planning sequences of mathematics lessons with teams of teachers Fostering knowledge of content and curriculum Pressing teachers to contribute ideas and opinions Encouraging teams of teachers to evaluate possible lesson ideas
Professional learning teams	Facilitating regular team meetings that examine student work samples, analyse assessment tasks and related data Engaging in professional discourse which contributes towards teacher learning Developing teachers' mathematical content knowledge and pedagogical content knowledge Sharing knowledge of effective practice Encouraging professional reading
Ongoing professional learning	Engaging in ongoing learning by doing / on-the-job Improving their personal understanding of mathematical knowledge for teaching and effective leadership through professional learning opportunities Frequently engaging in reflective practice
Leadership (Fullan, 2001)	Acting with moral purpose Using a range of effective leadership skills Building relationships based on trust, respect and commitment Understanding change Encouraging coherence in approach and programs
Learning communities (Lave & Wenger, 1991)	Building collaborative professional learning communities Meeting regularly with teachers in professional learning communities Encouraging effective and productive professional learning communities Belonging to an external community of learners as part of a network

Effective School Mathematics Leaders support teachers' professional learning by …	
Working alongside teachers in classrooms	Co-planning mathematics lessons Modelling teaching of mathematics lessons for teachers to observe with a goal in mind Team teaching as the more knowledgeable other Coaching individual teachers on aspects of effective practice Observing teacher practice and providing appropriate feedback related to a specific focus Noticing through expert eyes that encompasses organising, representing and interpreting information Reflecting on teacher practice, analysing aspects of the lesson and discussing how to improve the lesson
Personal qualities	Possessing: Enthusiasm Passion Expertise Self-assurance Commitment Humility A positive disposition
Networks	Sharing knowledge and opportunities that result from supportive collegial networks and partnerships outside of the school

Underpinning the list of actions were the two theoretical lenses used to frame this study and analyse the data, teacher learning and leadership. While Table 8.1 incorporates a compilation of the actions of effective School Mathematics Leaders as a result of the data analysis, it also draws upon the theoretical frameworks used to support this study: Fullan's (2001) Framework for Leadership (Figure 2.1) and Lave and Wenger's (1991) belief that learning takes place as part of social practice. Elements of all five leadership characteristics of effective leadership "moral purpose, understanding change, relationship building, knowledge creation and sharing and coherence making" (2002a, p. 3) are interwoven throughout Table 8.1. Together the findings and the literature informed and identified effective mathematics leadership practice that has the potential to lead to teacher change (Fullan, 2001) and teacher learning as part of a community of practice.

8.5 The Importance of the School Mathematics Leader

In summary, the evidence showed that School Mathematics Leaders were a key to supporting primary school teachers in improving the teaching and learning of mathematics. The findings highlighted the essential link that School Mathematics Leaders provided between school leadership and the classroom teacher. Effective School Mathematics Leaders acted with the intention of making a positive difference to the teachers they worked with as they supported them to learn to improve their mathematics teaching and learning. It could be said that these leaders "who assume responsibility for something they care deeply about … stand at the gate of profound learning" (Barth, 2001, p. 445). Through their knowledge, skills and actions, School Mathematics Leaders supported effective mathematics practice in schools and provided opportunities for teacher professional growth, which is "where teacher leadership and professional development intersect" (Barth, 2001, p. 445).

8.6 Suggestions for Further Research

Findings from this research confirmed the importance of School Mathematics Leaders. While the recommendation was to conduct case studies of four School Mathematics Leaders within the time frame of the project, there is potential for further research to be undertaken involving a longitudinal study of School Mathematics Leaders from other parts of Victoria or Australia. A comparison with School Mathematics Leaders from secondary schools and non-government schools could also be an option. It would also be informative to interview teachers and learn their perception of the support provided by the School Mathematics Leaders.

While some of the findings are reminiscent of work already described in the literature related to School Mathematics Leaders (Cheeseman & Clarke, 2005, 2006; Sexton & Downton, 2014a, 2014b; Corbin, McNamara & Williams, 2003; Millet & Johnson, 2000; Sullivan, 2011), the resulting findings build on prior studies. The findings have contributed to advancing knowledge in the field of mathematics leadership and have provided some new insights into this topic. However, this study has raised further questions about a particular finding that warrants further research.

As the interview and survey data was self-reported by the School Mathematics Leaders, a further consideration in hindsight would have been to observe these leaders working with teachers in the classroom. Working alongside teachers in the classroom tends to be a powerful way to support teachers, as is attending team planning and professional learning team meetings. The original design of the study was to observe teacher meetings. Had the importance of School Mathematics Leaders working with teachers in classrooms been obvious initially, the study might have been designed differently.

There is a gap in the research literature related to working alongside teachers in the classroom. Further research would provide interesting insights into the effectiveness of the School Mathematics Leaders support. It would be desirable to find out what School Mathematics Leaders say and do, what difference it makes to teacher practice, student outcomes and engagement, and how they make the decisions they make. Researching the effectiveness of School Mathematics Leaders working alongside teachers in the classroom and how this particular practice helps teachers to learn, is an area for further research and further consideration.

8.7 Conclusion

The aim of this research was to investigate the ways in which School Mathematics Leaders supported primary teachers' professional learning. While there was no doubt that School Mathematics Leaders supported teachers to learn, how this occurred was complex. This study explored and suggested a variety of possible ways this could be achieved. The findings confirmed that School Mathematics Leaders, teachers and principals must work in close alignment to make lasting improvements. While student achievement in mathematics depends on the quality of teaching, this in turn depends on their teachers' mathematical knowledge for teaching. The evidence showed that developing this knowledge occurred through productive learning opportunities created and facilitated by School Mathematics Leaders. Through their knowledge, skills and actions School Mathematics Leaders supported teachers to learn and grow professionally to develop effective practice in the teaching of primary mathematics.

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Appendices

Appendix A: Data Collection Timeline

Data Collection Timeline	2016 Aug	Sept	October				Nov				Dec				2017	Feb				March				April				May				June			
Survey administered																																			
Prompted written reflections																																			
Initial Visit		Jane Amy	Robyn				Susan																												
Observations			1	2	3	4	1	2	3	4	1	2	3	4		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Jane																																			
Amy																																			
Robyn																																			
Susan																																			
Interviews			1	2	3	4	1	2	3	4	1	2	3	4		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Jane																																			
Amy																																			
Robyn																																			
Susan																																			

Appendix B: Copy of Survey

School Mathematics Leaders Survey

Monash University: An Investigation of the ways that School Mathematics Leaders support teachers professional learning and development

Explanatory Statement

Dear School Mathematics Leader,

I am investigating ways that School Mathematics Leaders support the professional learning and development of teachers in their schools.

Results from this study will contribute to knowledge about effective practice of School Mathematics Leaders and provide evidence of the valuable support these leaders provide to teachers.

You have been invited to participate in this survey because you are an experienced School Mathematics Leader. Following completion of this survey you may be contacted and asked if you would like to be a participant in the larger research project.

The survey should take approximately 10 mins to fill in. Please be accurate and honest in your responses. There are no right or wrong answers to the items. You should feel free not to answer any particular questions if you do not wish to, and to stop filling out the survey at any stage.

Storage of the data collected will adhere to the University regulations and kept on University premises in a locked cupboard/filing cabinet for 5 years. A report of the study may be submitted for publication, but individual participants will not be identifiable in such a report.

If you would like to be informed of the aggregate research findings, please contact:
Kerryn Driscoll on mobile: 0410 186826 or email: driscoll.kerryn.k@edumail.vic.gov.au
or
Dr Jill Cheeseman on Ph: (03) 9904 4246 or email: Jill.Cheeseman@monash.edu

If you have a complaint concerning the manner in which this research (CF16/2133 - 2016001046 is being conducted, please contact:

Executive Officer
Monash University Human Research Ethics Committee (MUHEC)

Building 3e Room 111
Research Office
Monash University VIC 3800

Tel: +61 3 9905 2052
Fax: +61 3 9905 1420
Email: muhrec@adm.monash.edu.au

Thank you for agreeing to participate in the survey. Responses will be kept strictly confidential and individual responses will not be identified or reported. Your participation is entirely voluntary.

Click Next >> to start the survey.

Q1 Name

____

Q2 School/Location

____

Q3 What is your school's current student enrolment?

- Less than 100 students (1)
- 100–200 students (2)
- 200–300 students (3)

- 300–500 students (4)
- 500–800 students (5)
- 800+ (6)
-

Q4 How many teachers work at your school (excluding teacher support staff)?

____

Q5 How many years have you taught at your present school?

____

Q6 How many years have you been teaching in primary schools?

1–5 years (1)

5–10 years (2)

10–20 years (3)

20–30 years (5)

30 years + (6)

Q7 How did you become the School Mathematics Leader?

Volunteered (1)

- Applied for the role (2)
- Nominated by the principal (3)
- Other (please specify) (4)

____

Q8 How many years have you been a School Mathematics Leader?

- 1–2 years (1)
- 2–3 years (2)
- 3–4 years (3)
- 4–5 years (5)
- 5 + years (please specify) (6)

____

Q9 What year levels are you responsible for in leading mathematics?

- Foundation - 2 (1)
- Levels 3 - 6 (2)
- Whole school (3)
- Other (please specify) (4)

____

Q10 Do you have a formal role description as a School Mathematics Leader?

- Yes (1)
- No (2)

Q11 Thinking about my role as a School Mathematics Leader I feel supported by the principal

- 0 (0)
- 1 (1)
- 2 (2)
- 3 (3)
- 4 (4)
- 5 (5)
- 6 (6)
- 7 (7)
- 8 (8)
- 9 (9)
- 10 (10)

Q12 Are you a member of the school leadership team?

- Yes (1)
- No (2)

Q13 Do you have classroom teaching responsibilities?

- No (1)
- Yes (please specify) (2) ____

Q14 What additional responsibilities do you have and what is the time fraction for these? (e.g. team leader etc.)

____

____

____

____

Q15 Do you have time release for the role of primary School Mathematics Leader?

- Yes (please specify **number of hours** per week) (1)

____

- No (2)

Q16 How many hours a week do you believe you need to adequately fulfill the role of School Mathematics Leader at your school?

- 1–2 hours (2)
- 2–4 hours (3)
- 4–6 hours (4)
- 2 days (5)
- Other (please specify) (1)

____

Q17 How often do you meet formally with your teachers about mathematics?

- Twice weekly (6)
- Weekly (4)
- Fortnightly (5)
- Monthly (3)
- Termly (2)
- Yearly (1)
- Other (please specify) (8)

____

Q18 What is the purpose of your meetings? (multiple responses are accepted)

Planning (1)

Professional learning and development (2)

Data analysis (3)

Other (please specify) (4)

____

Q19 What is your role during these meetings? (multiple responses are accepted)

Attend as a participant (1)

Conduct the meeting (2)

Support with planning (3)

Provide professional learning (7)

Develop data literacy (6)

Mentor teachers (8)

Other (please specify) (5)

____

Q20 When do these meetings occur?

During school hours (1)

Before or after school (2)

Other (please specify) (3)

____

Q21 In what ways do you support mathematics professional learning in your school?

____

____

____

____

____

Q22 List at least three key challenges you have experienced as a School Mathematics Leader?

____

____

____

____

____

Q23 List at least three achievements you have initiated in your role as a School Mathematics Leader?

____

____

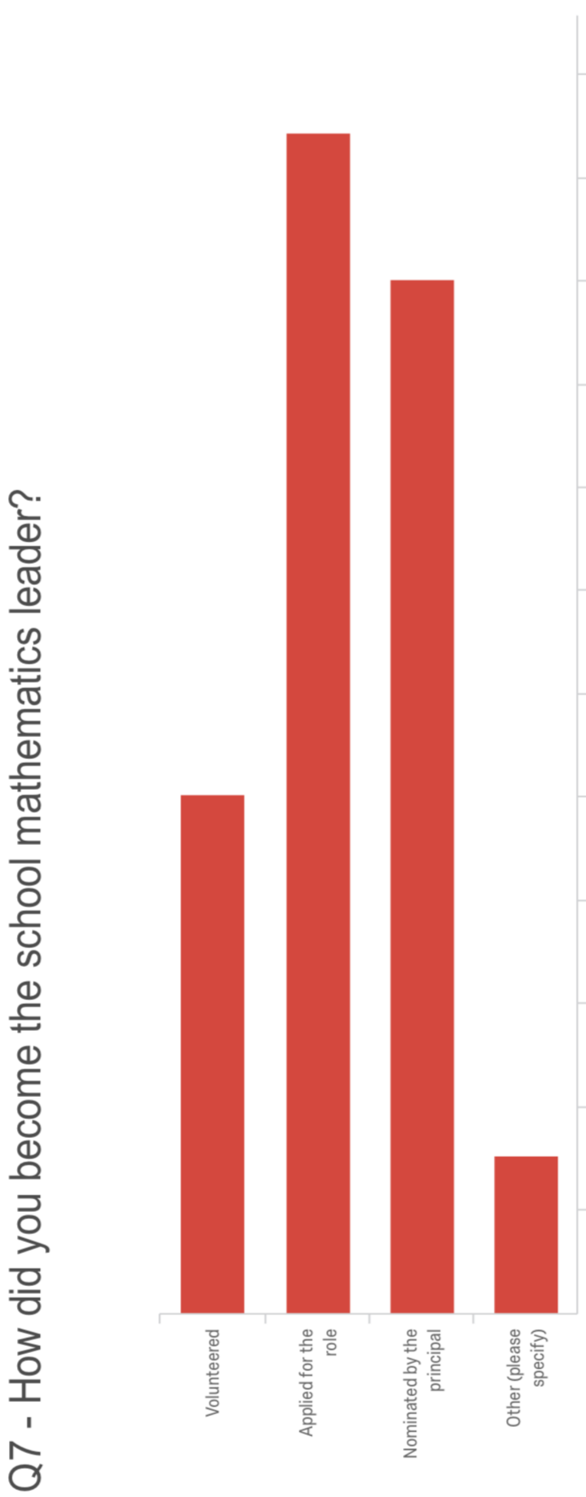
____

____

____

End of Block: Block 1

Appendix C: An Example of the Survey Responses Using Qualtrics



#	Field	Choice Count	
1	Volunteered	17.95%	10.05
2	Applied for the role	40.84%	22.87
3	Nominated by the principal	35.77%	20.03
4	Other (please specify)	5.45%	3.05
			56.00

Appendix D: Interview 1 Questions

Interview Questions for School Mathematics Leaders—Interview 1

Leadership

- How do you feel your role as a School Mathematics Leader has been? (1 m)
- What do you think contributed to this? How did that help? (1 m)

Professional Learning

- How have you supported individual teachers' professional learning in your school? Can you give me an example? (2 m)
- What successes resulted from this? (2 m)
- What have been some of the main challenges in supporting teachers' professional learning? How have you attempted to overcome these challenges? Can you give me an example? (4 m)
- What mathematics professional learning have you undertaken recently and how do you continue to grow professionally? (2 m)

Learning Communities

- Can you describe how teams collaborate at your school? (2 m)
- What opportunities have you had to support the professional learning of teams of teachers at your school? (2 m)
- What challenges have you experienced? How did you support teachers through this? (2 m)
- Can you describe a time when you felt that you had made a difference? (2 m)

Reflective Questions

- Can you tell me about your principal's support? (2 m)

<u>Refer to survey responses in 21 (4 m)</u>
Can you clarify the points you made in relation to—supports … e.g., use of outside consultants
After answering questions
Ask:

- **Is there anything more that you would like to add?**
- **Can you give me an example of that?**
- **Can you tell me more about …?**
- **Could follow up with an email**
- **Stop and check that my questions have all been covered.**
- **Make a time for the next observation and visit.**

Appendix E: Interview 2 Questions

Interview Questions for School Mathematics Leaders—Interview 2

Leadership

- What are some of the most significant changes influenced by you at your school? (4 m)
- What were some of the challenges? Why were these an issue? (2 m)

Professional Learning

- What are some examples of professional development opportunities available to staff? (Internal/ external PD) Who manages this? (2 m)
- Can you tell me about any mathematics professional learning that has been a recent focus in your school? (2 m)
- Is the mathematics professional learning focused on individual teachers? If so, why? (2 m)
- How was the focus decided? (1 m)
- Do you have a goal/s for mathematics professional learning for each team? (2 m)
- Are they short term or long-term goals? (1 m)
- Can you describe it/them? (2 m)

Learning Communities

- How do you see your role within the learning communities? (2 m)

Reflective Questions

- Can you share any ways you feel your role in supporting teachers' professional learning could be enhanced? (3 m)

Refer to survey responses in 22 (4 m)
Can you clarify the points you made in relation to—challenges …e.g., building own capacity
After answering questions
Ask:

- **Is there anything more that you would like to add?**
- **Can you give me an example of that?**
- **Can you tell me more about …?**
- **Could follow up with an email**
- **Stop and check that my questions have all been covered.**
- **Make a time for the next observation and visit.**

Appendix F: Interview 3 Questions

Interview Questions for School Mathematics Leaders—Interview 3

Leadership

- If you were to start the role again with your current knowledge, is there anything you would do differently in implementing your role? (4 min)

Professional Learning

- What new learning do you think your staff/team should be focusing on? (2 m)

Learning Communities

- What motivates you to continue to support the teachers in your school? (4 m)

Reflective Question

- If you were to give advice to school maths leaders, what do you think it would be? (4 m)
- What do you believe is the best way to influence and support teachers here at the moment in this school? (3 m)
- How are you developing your knowledge then at the moment? (2 m)

Survey Responses (5 m)

Can you clarify the points you made in relation to achievement e.g. shared planning documents?

Individual Follow up Questions

More specific questions related to previous interviews and observations

After answering questions

Ask:

- **Is there anything more that you would like to add?**
- **Can you give me an example of that?**
- **Can you tell me more about …?**
- **Could follow up with an email**

Stop and check that my questions have all been covered.

Make a time for the next observation and visit.

Appendix G: Interview 4 Questions

Interview Questions for School Mathematics Leaders—Interview 4—Jane

Leadership

- If you were to give advice to School Mathematics Leaders what would it be? (5 m)
- What do you believe is the best way to influence and support teachers in your school? (4m)

Professional Learning

- What <u>new learning</u> would you like to see in your staff this year? (2 m)
- What is your role in the XXXX Regional Network and what part do you feel it will play in supporting teachers? (2 m)
- Will you encourage it to continue? Why? (1 m)

Learning Communities

- How often do work with teams in your leadership role this year? (2 m)
- How are you developing teacher knowledge? (3 m)
- How do you approach teachers whose ideas are different from yours or you don't agree with what they are doing (4 m)

Reflective Questions

- How do you feel you can support new maths leaders? (5m)
- What do you believe School Mathematics Leaders need to be effective? (3 m)
- Where do you see your role going next? (2 m)
- How much of your own time is spent working on maths? (1 m)

Survey Responses

<u>Can you clarify the points you made in relation to achievements</u> - … e.g. shared planning documents?

<u>After answering questions</u>

Ask:

- **Is there anything more that you would like to add?**
- **Can you give me an example of that?**

Appendix H: Prompted Written Reflection Format

Significant Incident A description of the incident, experience or interaction when working with teachers in your school. What did you do today that made a difference?	**So, What?** The significance. Your viewpoint, actions, emotions What was the response?	**Now What?** Further actions What would you do differently? What have you learnt?

Appendix I: Transcript of a Video Recording of a Planning Meeting Observation

D: So, what is the learning focus? The learning focus is about multiplicative thinking.

Jane: I don't know. Is it?

D: We are learning to. So, to represent practical situations to model sharing. We are learning to …

K: Well on here there's whole number operations. These are the outcomes, counting strategies

Jane: No

K: Sorry are we talking about animal legs?

D: No. I'm onto Doorbell Rang

K: Multiples, fair shares, sharing, I mean like fractions, remainders

Jane: What do you want them to know?

D: We are learning strategies for sharing equally. How did I go?

Jane: I don't know. How did you go?

D: Because I always get stuck when you say: What are they doing? What is the difference between what are they doing and what are they learning? No. We're learning to share things equally. Yeah. OK? Oh, here's some songs such as Baa, Baa Black Sheep. How many bags of wool for 5 sheep? We could do that as a warm-up.

Jane: We love a song

D: Everyone loves a song

Jane: The idea of one for the whatever. Yeah. Good and you've got your story. Yeah, you could and then you've got your story shell.

D: So, we are learning to. We are learning strategies. Do they know that word? Ways that … We are learning different ways to share things equally.

Jane: Are they learning different ways?

O: We are learning to share things equally. To share things equally with others

D: They could come up with things themselves. We are learning how to share things equally. Share things equally. How things can be shared equally.

Jane: Um

D: We are learning how to share things equally.

Jane: Move on

D: So, our warm-up is sing Baa, Baa Black Sheep

Jane: What’s going on?

K: Hang on. For this one, our warm-up could be reading the book.

D: Yeah. No. Isn’t that the launch? The story shell of the Doorbell Rang

K: Well. I guess when we did it, that’s how we did it last time, but we could stick with that.

Jane: Makes sense

Appendix J: Monash Ethics Approval

MONASH University
Monash University Human Research Ethics Committee (MUHREC)
Research Office

Human Ethics Certificate of Approval

This is to certify that the project below was considered by the Monash University Human Research Ethics Committee. The Committee was satisfied that the proposal meets the requirements of the *National Statement on Ethical Conduct in Human Research* and has granted approval.

Project Number: CF16/2133 - 2016001046

Project Title: An investigation of the ways that School Mathematics Leaders support teachers' professional learning and development.

Chief Investigator: Dr Jillian Cheeseman

Approved: From: 13 July 2016 **To:** 13 July 2021

Terms of approval - Failure to comply with the terms below is in breach of your approval and the Australian Code for the Responsible Conduct of Research.

1. The Chief investigator is responsible for ensuring that permission letters are obtained, if relevant, before any data collection can occur at the specified organisation.

2. Approval is only valid whilst you hold a position at Monash University.

3. It is the responsibility of the Chief Investigator to ensure that all investigators are aware of the terms of approval and to ensure the project is conducted as approved by MUHREC.

4. You should notify MUHREC immediately of any serious or unexpected adverse effects on participants or unforeseen events affecting the ethical acceptability of the project.

5. The Explanatory Statement must be on Monash University letterhead and the Monash University complaints clause must include your project number.

6. Amendments to the approved project (including changes in personnel): Require the submission of a Request for Amendment form to MUHREC and must not begin without written approval from MUHREC. Substantial variations may require a new application.

7. Future correspondence: Please quote the project number and project title above in any further correspondence.

8. Annual reports: Continued approval of this project is dependent on the submission of an Annual Report. This is determined by the date of your letter of approval.

9. Final report: A Final Report should be provided at the conclusion of the project. MUHREC should be notified if the project is discontinued before the expected date of completion.

10. Monitoring: Projects may be subject to an audit or any other form of monitoring by MUHREC at any time.

11. Retention and storage of data: The Chief Investigator is responsible for the storage and retention of original data pertaining to a project for a minimum period of five years.

Professor Nip Thomson
Chair, MUHREC
cc: Mrs Kerryn Driscoll

Monash University, Room 111, Chancellery Building E 24 Sports Walk, Clayton Campus, Wellington Rd Clayton VIC 3800, Australia

Telephone: +61 3 9905 5490
Facsimile: +61 3 9905 3831
Email: muhrec@monash.edu http://intranet.monash.edu.au/researchadmin/human/index.php

ABN 12 377 614 012 CRICOS Provider #00008C

Appendix K: Department of Education and Training Ethics Approval

Department of
Education & Training

2 Treasury Place
East Melbourne Victoria 3002
Telephone: 03 9637 2000
DX210083

2016_003117

Mrs Kerryn Driscoll
36 Clifton Street
CLIFTON SPRINGS 3222

Dear Mrs Driscoll

Thank you for your application of 21 June 2016 in which you request permission to conduct research in Victorian government schools titled *An investigation of the ways that school mathematics leaders support teachers' professional learning and development.*

I am pleased to advise that on the basis of the information you have provided your research proposal is approved in principle subject to the conditions detailed below.

1. The research is conducted in accordance with the final documentation you provided to the Department of Education and Training.

2. Separate approval for the research needs to be sought from school principals. This is to be supported by the Department of Education and Training approved documentation and, if applicable, the letter of approval from a relevant and formally constituted Human Research Ethics Committee.

3. The project is commenced within 12 months of this approval letter and any extensions or variations to your study, including those requested by an ethics committee must be submitted to the Department of Education and Training for its consideration before you proceed.

4. As a matter of courtesy, you advise the relevant Regional Director of the schools or governing body of the early childhood settings that you intend to approach. An outline of your research and a copy of this letter should be provided to the Regional Director or governing body.

5. You acknowledge the support of the Department of Education Training in any publications arising from the research.

6. The Research Agreement conditions, which include the reporting requirements at the conclusion of your study, are upheld. A reminder will be sent for reports not submitted by the study's indicative completion date.

VICTORIA State Government

I wish you well with your research. Should you have further questions on this matter, please contact Youla Michaels, Project Support Officer, Insights and Evidence Branch, by telephone on (03) 9637 2707 or by email at michaels.youla.y@edumail.vic.gov.au.

Yours sincerely

Joyce Cleary
Director
Insights and Evidence

29/07/2016

VICTORIA State Government

Appendix L: Coding Examples Used in NVivo for Interview Data

Category of Code	Description of Code	Elaborations	Example of comment from the data
Mathematical content knowledge (MCK) Ball et al., (2008) Teachers	<u>Common content knowledge - CCK</u> Mathematical knowledge and skill that is commonly shared by both teachers and other users of mathematics that is not unique to teaching (p. 399)	- Knowledge of how to solve algorithms - Knowledge of fractions - Recognising a wrong answer - Ordering a list of decimals	"I think teachers have it in their head you have to know [formal algorithms] for NAPLAN and you have to know it for when you go to grade six … because you're going to need it for high school" (Amy).
School Mathematics Leader	<u>Horizon content knowledge - HCK</u> Awareness of how mathematical topics are related and developed over the span of mathematics included in the curriculum (p. 403)	- Knowledge of how mathematics ideas and topics are connected across the curriculum e.g. multiplication	"But multiplication isn't covered in Level 2, is it?" [Team leader, video 1- Amy]
	<u>Specialised content knowledge - SCK</u> Mathematical knowledge of representations, ideas, concepts and skills that are unique to teaching which goes beyond what is expected of most adults (p. 400)	- Understanding how a student might solve a mathematical problem using mental strategies - Understanding how to effectively make, choose and use mathematical representations	"That pre-algebra understanding as well is something that I've identified that a lot of people don't see the importance of it. They think it's a secondary thing. But we can do so much to help that in primary. I think this year I have focussed on it a bit" (Susan).
Pedagogical content knowledge (PCK) Shulman (1987) Ball et al., (2008)	<u>Knowledge of content and curriculum - KCC</u> Knowledge about mathematics and knowing how mathematics knowledge is represented in curriculum documents and materials (p. 391)	- Knowledge of the curriculum content and documents e.g. Victorian Curriculum, essential learnings, proficiencies	"At the moment led by leadership it has been developing our shared expectations, which came out in our survey very strong. That is the one thing they think is developing consistency across the school" (Amy).
1. Teachers School Mathematics Leader	<u>Knowledge of content and students - KCS</u> Knowledge that combines knowing about students and knowing about mathematics (p. 401)	- Anticipating what students are likely to think, do and what they will find confusing - Predict what they will find interesting and motivating - Being aware of student conceptions and misconceptions about content	"She thought the things that she was giving the child would engage him, but he was whizzing through everything, so it was like, "Well what can I do that's next?" I think by using those open-ended tasks, it's not like a very quick, "I'm done," it's like, "No, there's more. What else can you show me?" type thing. So more getting into that time-intensive task" (Robyn).
	<u>Knowledge of content and teaching (mathematics) - KCT</u> Knowledge that combines knowing about mathematics and knowing about teaching (p.401) "An interaction between specific mathematical understanding and an understanding of pedagogical issues that affect student learning" (Ball et al., 2008, p. 401).	- Knowing how to design instruction, sequence content and select the most appropriate tasks, models, representations and materials to support student learning	"We still have quite a few people here who like streamed groups, so differentiation might be a good one [topic to focus on] in terms of just being able to cater for the spread or the range within a classroom" (Amy).

Category of Code	Description of Code	Elaborations	Example of comment from the data
School Mathematics Leader practice **Spillane, Halverson & Diamond (2001)** "To investigate leadership practice, it is necessary to move beyond an analysis of the micro tasks and to explore their enactment" **Spillane, Halverson & Diamond (2001, p. 24)**	**The actual work of leading mathematics in schools.** **Working with and supporting teachers by:** **1. coaching** **2. mentoring** **3. modelling** **4. planning** **5. team teaching** **6. using data** **7. resourcing** **8. reflecting on the role**	- School Mathematics Leaders supporting teachers formally and informally in professional learning teams, planning meetings and in classrooms through: - coaching - mentoring - modelling - planning - team teaching - developing data literacy - providing resources then reflecting on the nature of the role -	**1. Coaching** "I know some people have that coaching model but I think the most valuable coaching is on the spot" (Susan). **2. Mentoring** "I suppose it's about even within the team, sometimes it's not me supporting them directly but me supporting Dxx to lead her team effectively" (Jane). **3. Modelling** "We've had a couple of sessions where I've been able to demonstrate a lesson or let the staff do a lesson. At the very beginning of the year and a couple of sessions last year I was able to do that, and it gets people very motivated to try some" (Robyn). **4. Planning** "It's our unit from last year. We'll review it. Everything we do is embedded in. If someone makes a worksheet it's embedded or if someone makes a game it's embedded, so it's all in one place" (Susan). **5. Team teaching** "But I would like to expand and probably that'll be my term four goal, and maybe even this term we might get some done where I do some team teaching with a couple of those teachers and just show them what can happen" (Robyn). **6. Using data** "We fill out a data discussion template where we analyse the data to see what students already know and what they need to learn" (Susan). **7. Resourcing** "I did it in an hour. I got an hour off because someone … said, "We're just doing assessment, do you want the hour off?" And I said, "Yes." And I sat with XX and I spent \$3,600 in one hour, and here it is" (Amy).

Category of Code	Description of Code	Elaborations	Example of comment from the data
			8. Reflecting on the role "I think we struggled with that [role description] at the start, like not having clarity, as everyone does. We just want to be told what you want us to do, and we'll do it" (Amy).
Building learning communities **Lave & Wenger (1991)** **Du Four & Marzano (2011)**	Teams of teachers working together collaboratively planning, analysing assessment data, developing mathematical curriculum knowledge, improving practice.	- Teams of teachers working together in professional learning teams or communities (PLTs or PLCs)	"In our PLTs they have a driving question, action research question and they lead the research embedded in their practice and it's connected back to it" (Jane).
Professional learning and development **Anderson, Bobis & Way (2008)** **Fullan & Hargreaves (2016)** **Faragher, Southwell & Gaffney (2014)**	**Professional learning** Refers to continual professional growth in teacher practice and expertise through participation in professional development. It also occurs through day-to-day practices, classroom experiences, professional reading and in more formalised educational training settings.	- Moderation of assessment data in a PLT - Involvement in Japanese lesson study - School Mathematics Leader shares a professional reading	**Professional learning** "We said everyone bring their problem solving next week … everyone just lay it out on the table. We'd talk about all the different strategies [they] use, and look at the teaching points from that" (Susan).
	Professional development Refers to formal programs such as planned activities that teachers undertake which build teacher professional learning.	- Teachers or School Mathematics Leaders attend workshops or conferences	**Professional development** "They're offering free PD, so he's coming out to do this PD tomorrow as part of the staff meeting … and he gave me a list of things. We picked differentiation" (Amy).
Relationships **Fullan (2002)** **1. Principals**	Between **principal** and the SML **- positive (constructive)** **- negative (destructive)**	- Positive, productive relationships with principal - Negative destructive relationships	**Positive** "I feel I have complete trust, but I could walk into her office at any time and she will give me an hour" (Jane). **Negative** I have not found one as yet
2. Teachers	Between **teachers** and the SML **- positive (constructive)** **- negative (destructive)**	- Positive relationships developed with individual teachers at the school - Negative destructive relationships	**Positive** "I think, in terms of leadership building those relationships is such an important part of what I do, and having that staff trust" (Susan).

Category of Code	Description of Code	Elaborations	Example of comment from the data
			Negative "With [Teacher 2] she doesn't talk, so you would have noticed [team leader] not saying, "What do you think?" She's very different when I'm around. She has some kind of authority thing, which is weird" (Jane).
Challenges/ Difficulties **Millet (1998)**	Situations that test someone's ability to perform their role.	- Time to implement the leadership role - Funding for resources or time release to work with teams of teachers - Principal's priorities	"I think it's always time. That's the big one. Because I guess if they come to you, they're wanting help, and just being given the time, even as a whole staff" (Robyn).

Appendix M: Example of a Planning Matrix

Planning	Challenges to teacher learning e.g. time, SML confidence,	Developing teachers MCK and PCK Developing relationships	Actions of SMLs Building PLCs
Robyn	**Amy**	**Jane**	**Susan**
Reference 1: (Plan in pairs) K: Do you share it [the planning] with the other teachers? R: Yeah, the whole three, four team K: Right, is it all in your planning? R: Yes. **Reference 2:** Well the way it's worked this year is that we've sort of been like two teams of two, just for time release. So, **I plan with XX, because our time release is together, and the other two teachers sort of plan together** and we both have very different styles. **Reference 3: (Beliefs)** But yeah, we do, and all this stuff, I share with the team, it's all on our Google Drive, and it's like, okay we're doing angles, go to the Peter Sullivan stuff. **I know there's teachers that still do a lot of other, but** I feel like if you start with this gig, you get into the nitty gritty of it, you don't need to be doing **worksheets**. **Anyway, that's just different styles. (Approach to teaching- her way vs worksheets)** **Reference 4:** When's your planning, then? **Reference 5:** Oh, just through time release	**Reference 1: (Believes that collaborative planning works best but teachers do not do this at her school.)** PLT three that I was working with, **were keen to do it** [plan collaboratively] in the second half of the year and get the timetable changed to fit, so they all had an hour off. I went to the leader of that team last week and said, "Are you still interested in doing that in the second half of the year?" She said, "I don't think I can get all my team **on board."** So, it will be interesting. And she is going to have two new members of the team. **Reference 2:** Had they been able to plan together as well, do you think that would help too? **Reference 3**: I would like to try and see if it does have an impact, that's for sure. **Reference 1:** Teachers have to have their planners up by 9.00 am on Monday. We've never done that in the past. So that's massive, as you can imagine. So, we're still chasing some people every week because they don't have a planner up. But that's not okay.	**Reference 1: (Leads 2 teams to plan)** Each leading teacher has **2 teams, so we plan with each team for 2 hours a week.** **Reference 1:** So, we picked it out. We've just kind of written in so prep you would teach these things in each area. **Reference 2:** It's pretty much just the standards, but then each one has a unit of work where we've got the standards and a developmental sequence from one of our key texts and it used to have resources for each one, **but gradual release.** In this version, I took it out of each unit and I just put a basic cover sheet for each topic. For us this was about **covering the curriculum,** but also **it built better pedagogical content knowledge** because as they followed it they went to it for resources and now they're getting to the point where **their content knowledge is higher** **(Teachers needed support with planning)**	**Reference 1: (Supports all teams)** Basically, what I do is **I have an hour with every year level.** I'll go into the planning. **There's also a PLT leader in primary, whose also there to run the planning with me.** So, what we'll do is we'll look at the agenda. So, some year levels might be only doing one unit of work or some might be doing two. So, we will touch base with what they are up to in regard to their current unit of work. **Reference 2: (Planning steps)** We will come up with a question or a task based on what we've been doing that week. Everyone will bring that to planning and we will kind of use that to gauge if we need to keep going, or if we need to reteach. What do we need to do? **Reference 3:** So, we will bring that, analyse it and then discuss the next lessons. We will review the unit of work, because we've been using our unit of work now for probably 2 to 3 years. We will go through and have a look if we need to add to lessons, modify them. Can we just use what we have got there? Usually we will need to add in a couple of things.

Appendix N: Overview of Coding: Levels 1, 2, 3, 4, and 5 Codes

Survey Codes	**Level 1** **Compiling** **Interview NVivo codes**	**Level 2** **Disassembling**	**Level 3** **Reassembling** **Cross-case analysis**	**Level 4 Codes** **Interpreting** **Themes emerged** **Linked survey data**	**Level 5** **Concluding** **Giving meaning to findings** **Drawing conclusions**
Professional learning & development	Professional learning & development	Professional learning & development	Developing teachers MCK & PCK	Developing teachers' mathematical knowledge for teaching (MKT)	**School Mathematics Leaders supported teacher learning in:** - mathematics planning meetings (observed) - professional learning team meetings (observed) - in classrooms (self-reported) **Effective School Mathematics Leaders:** - Develop constructive relationships with principals and teachers - Engage in ongoing professional learning - Possess certain personal qualities including confidence, expertise & self-assurance - Build collaborative professional learning communities focused on teacher learning (Lave & Wenger, 1991) - Creatively manage time - Lead with energy, hope enthusiasm (Fullan, 2002) - Use a range of effective leadership skills **Characteristics of Effective School Mathematics Leaders** See (Table 8.1)
Teacher content knowledge	Building teacher knowledge - MCK /PCK	MCK PCK			
Time	Challenges ▪ time to work with teachers ▪ teacher change	Challenges/Difficulties	Challenges created barriers to teacher learning ▪ time ▪ SML confidence ▪ role clarity	Effective mathematics leadership relies on several contributing factors ▪ relational trust between leaders and principals ▪ relational trust between leaders and teachers ▪ SML confidence ▪ role clarity ▪ personal qualities ▪ time	
School Mathematics Leaders' confidence	School Mathematics Leaders' confidence Uncertainty of the role	Confidence			
Teacher resistance	▪ Principal support ▪ Building trust and respect of teachers ▪ Relationships with the principal and teachers	Relationships – positive and negative ▪ principals ▪ teachers	Developing positive relationships with ▪ principals - support ▪ teachers		
Planning	Team collaboration	Building learning communities	Building professional learning communities - teams of teachers working together in planning and PLTs	Fostering opportunities for team collaboration and collegial support	
Working in classrooms	Supporting teachers to build expertise through:	School Mathematics Leader Practice	Actions of School Mathematics Leaders as they supported teacher learning	Working alongside teachers in the classroom to create opportunities for teacher learning	
	▪ modelling	▪ modelling			
	▪ mentoring	▪ mentoring			
	▪ coaching	▪ coaching			
	▪ planning	▪ planning			
	▪ team teaching	▪ team teaching			
Assessment & data	▪ using assessment & data	▪ using assessment & data			
Budgets & resources	▪ resourcing	▪ resourcing			
	▪ implementing the role	▪ reflecting on the role	Leading mathematics	Effective mathematics leadership	