SCHOOL LEADERSHIP & MANAGEMENT
2023, VOL. 43, NO. 3, 238–260
ISSN: 1363-2434 | E-SSN: 1364-2626

The practices of middle leaders of mathematics: alignment of their goals and activities

Colleen Vale , Anne Roche, Jill Cheeseman, Ann Gervasoni, Sharyn Livy and Ann Downton

School of Curriculum, Teaching and Inclusion, Faculty of Education, Monash University, Melbourne, Australia

ABSTRACT

Leading school mathematics is a complex task and the responsibilities and activities involved are not always clearly defined. School mathematics leaders (SML) in Australian schools are often expected to lead improvement in mathematics teaching and learning. Previous research typically focuses on the qualities of effective leaders rather than the practices of SMLs. Investigated in this study were the goals and activities of Victorian primary (elementary) and secondary SMLs and the alignment of their goals and activities. The most frequent goals focused on teams developing shared understandings and practices for improving learning and teaching. The activities of SMLs included a diverse range of activities inside and outside the classroom, irrespective of the leaders' main goal. These findings have implications for the professional learning of SMLs and highlight the importance of leaders being provided with sufficient time to undertake leadership practices that align their leadership activities with their leadership goals.

KEYWORDS

School mathematics leader; middle leader; mathematics leadership goals; leadership practice

School leaders, that is, principals are expected to plan and enact improvement in teaching and learning in their school. This is referred to as instructional leadership in the literature (York-Barr and Duke 2004) and education system policy documents (e.g. Department of Education and Training [DET] 2020). Spillane, Halverson, and Diamond (2001) note that school leaders use a distributed leadership practice to assign the leading of improvement for specific learning areas, such as mathematics, to a teacher in their school. Grootenboer, Edwards-Groves, and Rönnerman (2015) describe the teacher who takes on the role of leading a particular curriculum area in their school as a middle leader. They argued that middle leadership is significant because middle leaders are located between the school leader and teachers and therefore participate in both the leadership

and teaching practices of the school. Also, as they are teachers, typically middle leaders are aligned philosophically with their teacher colleagues and, therefore, can collaborate with teachers during their day-to-day practices. Middle leading is a complex task (Grootenboer, Edwards-Groves, and Rönnerman 2015). It involves teaching, administration, managing, implementing curriculum changes, and improving pedagogical practices for a school subject area (Hjalmarson and Baker 2020; Sexton and Downton 2014).

Studies of leading mathematics teaching and learning have often reported on professional learning projects involving mathematics leaders (e.g. Borko et al. 2021; Sullivan 2020; Kazemi et al. 2018). Whilst studies of instructional leadership have theorised the role and responsibilities of middle leaders in transforming curriculum and teaching practices in schools and classrooms (Kemmis et al. 2014; Lingard et al. 2003), few studies have reported on the goals and practices of middle leaders of mathematics.

This study explores the practices of middle leaders of mathematics as they undertake an instructional leadership role in Victorian primary or secondary schools. In so doing, we aim to provide insights into what these school mathematics leaders report about their practices, including the goals and activities that their role involves, and the alignment of their goals and activities. The current study uses the title School Mathematics Leader (SML) (Driscoll 2017, 2021; Sexton and Downton 2014) to denote the role of the school middle leader of mathematics.

Background

This section begins with a description of the theoretical framework for middle leading used in this study (Grootenboer, Edwards-Groves, and Rönnerman 2015; Kemmis et al. 2014). This explanation is followed by information about school policies and practices regarding titles, appointment and roles of the SML for the education jurisdiction of this study. Finally, studies of SMLs' practices and activities are reviewed.

Theoretical framework – middle leading

Studies of middle leaders more generally and mathematics middle leaders more specifically have theorised about middle leaders' responsibilities (De Nobile 2018; Sexton and Lamb 2017). As noted above, a middle leader's responsibilities and practices are complex (Grootenboer, Edwards-Groves, and Rönnerman 2015) and vary according to individual and environmental factors (Ganon-Shilon and Schechter 2017).

Kemmis et al. (2014) theorised practice as:

> We thus include *sayings, doings* and *relatings* in our conceptualization of practices, and understand practices as enabled and constrained by three kinds of arrangements that

> occur at sites, namely, *cultural-discursive*, *material-economic*, and *social-political arrangements* (respectively) (30).

The sayings are 'things that are said', the doings are 'work or activities being done' and relatings are 'people in particular kinds of relating to one another' (Grootenboer, Edwards-Groves, and Rönnerman 2020, 26–27). The three contextual factors in the theory of practice architectures include the social practices, school policies about leadership responsibilities and opportunities for collaboration identified as cultural-discursive arrangements, school budgets and resources labelled the material-economic arrangements, and the relationships between the middle leader and school leaders called the socio-political arrangements (Kemmis et al. 2014). Furthermore, they argued that when the sayings, doings and relating 'hang together … in a project it makes particular kinds of practice distinctive' (Kemmis et al. 2014, 31).

School leaders of mathematics teaching and learning

As reported in the literature, there are no commonly recognised titles or clearly defined responsibilities for SMLs (Hjalmarson and Baker 2020). This is also the case in Victorian public schools. Indeed, there is no official position and description of middle leaders. Titles for SMLs have varied over time alongside different policy initiatives, such as coaches (a common term in the USA). The current common titles in Victorian schools of SMLs include Numeracy Learning Specialist, Numeracy Leader, Numeracy Coordinator, Mathematics Domain Leader and Learning Specialist. These leaders may or may not have received specific professional learning about leading mathematics. Professional learning has been provided for primary school teachers with the title of Numeracy Specialist. This programme, the Primary Mathematics and Science Specialist programme (Department of Education and Training 2022), focusses on improving teachers' knowledge of content, curriculum, and pedagogy. The appointment of teachers to the SML position varies between schools, with some teachers directly appointed and others completing applications within the school or when applying for an advertised teaching position at the school.

The Australian Institute for Teaching and School Leadership's Standards for Teachers (AITSL 2017), provides descriptors of competencies and knowledge for *leading* teachers, that is, the most experienced and capable teachers, without specific reference to a middle leadership position. These standards include planning and developing professional learning for colleagues (Standard 6.1), initiating collaborative relationships (Standard 6.2), implementing professional dialogue to improve outcomes of students (Standard 6.3) and leading strategies to support professional learning opportunities for colleagues (Standard 6.4) (AITSL 2017). However, SMLs are not necessarily appointed at the Leading Teacher level and are not necessarily the most experienced or knowledgeable teachers of mathematics in their school (Driscoll 2017).

SMLs tasked with the responsibility to improve the teaching and learning of mathematics rarely have role descriptions (Clarke et al. 2005; Department of Education and Training [DET] 2020; Sexton 2019) and leadership responsibilities may vary according to context such as the size of school or focus of school improvement goals (Grootenboer, Edwards-Groves, and Rönnerman 2015; Sexton 2019). When assisting classroom teachers to improve their knowledge for teaching mathematics, government bodies and school systems may provide additional funds to employ an experienced middle leader to lead improvements in mathematics teaching in a school or across a network of schools (Vale et al. 2010).

Goals of school mathematics leaders

Much has been written about the importance of school improvement goals, whereas there is less research about the goals that is, the narratives used by leaders to describe the shared understandings and practices that they want to develop to improve mathematics learning outcomes of students. We contend that these teacher-leaders play a critical role in mathematics education. We examined the research literature for SMLs' personal professional goals for improving learning outcomes in mathematics, in Australia and internationally. A literature search related to educational goals revealed studies written about system goals and advice to leaders of mathematics teachers (e.g. Borko et al. 2021) but very little about SMLs' professional goals for developing shared understandings for school improvement.

Gaffney and Faragher (2010) recommended two goals for sustainable improvement in mathematics outcomes: effective teaching of mathematics and high-level school leadership. Indeed, there is consensus that the greatest impact on student achievement is likely to occur when the school leader's responsibilities are focused on improving teacher practice (e.g. Hattie 2002; Robinson, Lloyd, and Rowe 2008; York-Barr and Duke 2004). These researchers drew on the results of empirical studies to frame advice as to goals for school leaders, but this advice did not identify the shared understandings SMLs need to develop with their colleagues.

Our search of the literature showed little evidence of documentation of Mathematics Leaders' goals for developing shared understandings and practices in elementary school contexts. A study by Higgins and Bonne (2011) examined instructional leadership in a primary school in New Zealand. In particular, how school leaders (principal and assistant principals), and numeracy lead teachers engaged in reforming mathematics teaching. These authors found that mathematics reform was more effective when a numeracy lead teacher also held a designated leadership position, such as assistant principal. The authors also identified key strategies that supported the implementation of the 'reform agenda': strong support from the principal; consistent on-going professional learning for staff; regular classroom observations; and sufficient time

to embed instructional practices. These factors align with the socio-cultural and material-economic elements of practice architectures (Kemmis et al. 2014). However, the study did not specify the particular understandings and practices to be developed or the professional learning approaches to be used by numeracy leaders.

Two Australian studies focused on SMLs' goals and practices for student learning and achievement in mathematics. Vale and colleagues (2010) focused on leadership practices and approaches to developing leadership skills to improve mathematics learning of students in 43 primary and secondary low socio-economic status schools in rural Victoria. These authors found that SMLs had a clear vision of school and classroom practice and set directions for improved student learning. In contrast, Wilkie and Tan's (2019) study focused on the goals of seven Australian secondary SMLs. The authors found that, due to teacher resistance, there was a mismatch between SMLs' goals and their implementation in some contexts. They also found that although SMLs had specific goals, school policy constraints could impact actual outcomes. Common to these studies were findings that SMLs have clearly stated goals and targets; and play a critical role in influencing change to improve student learning. It is less clear how these goals and targets provide evidence of the shared understandings and practices that SMLs wanted to develop.

Activities of school mathematics leaders

Lingard et al. (2003) claimed effective pedagogical leading engages teachers in collaborative, critical, and reflective discussions about their practices and students' learning. Productive leadership relies on school leaders providing support and opportunities for middle leaders to create a collaborative culture and practice. Martinovic and El Kord (2018) conducted a review of literature on leading mathematics in schools. Two studies focused on the 'activities' of SMLs. Masters (2010) reported that middle leaders analyse samples of student work, co-plan with teachers, co-teach lessons, review efficiency of teaching, and celebrate professional learning. Calderone, Kent, and Green (2018) reported qualities of middle leaders, including expertise in teaching and practices of leading such as actively listening, encouraging success of colleagues, facilitating communities of learning, confronting barriers in school culture and structure, and striving for authenticity in teaching, learning and assessment.

Studies in Australia have reported on the activities of SMLs during whole school improvement projects conducted by their education system (Clarke et al. 2005; Sexton 2019; Sexton and Downton 2014). Cheeseman and Clarke (2005) reported on the SML conducting demonstration lessons, co-teaching, using student assessment data for planning and having professional discussions

with teachers in formal and informal settings. In addition to these activities, Driscoll (2017, 2021) identified coaching, modelling, mentoring, conducting professional development activities and sharing academic readings as further activities undertaken by primary SMLs.

Sexton (2019) reported on the objectives and activities of SMLs. He conducted interviews with three SMLs at the end of a three-year project to improve school mathematics learning. He identified objectives along with the action and cultural tools used by teachers. For example, for the goal of 'developing consistent, shared understanding of mathematics planning and teaching practices' (Sexton 2019, 664), the SML facilitated meetings to discuss insights from demonstration lessons, co-taught lessons with teachers and collaborated with staff to set teaching goals. He identified resources (cultural tools) that were used for these activities. These findings fit with the theory of 'practice architectures' (Kemmis et al. 2014).

Lipscombe, Tindall-Forde, and Grootenboer (2019) used the theory of practice architectures to report two case studies of a primary and secondary school middle leader of mathematics conducting action research projects. They found that middle leaders can be influential in impacting teaching practices through such projects but this depends on the support of the school leader, time to work with teachers to conduct the project, a role description for the mathematics leader, and trusting relationships between teachers, the middle leader and school leader.

Whilst the literature shows middle leaders play an important role in school improvement (Farchi and Tubin 2019; Masters 2010), the responsibilities and expected activities of SMLs are not clearly specified by the education system. Studies have identified leadership goals and some have identified the practices of middle leaders. In this study, SMLs in Victorian government schools (Australia) were surveyed about their leadership goals and activities. In this paper, we report on the goals and activities of SMLs in primary and secondary schools and explore the alignment of their goals and activities. The research questions that framed this study were:

- What are the goals of middle leaders of mathematics in primary and secondary schools?
- What are the activities of middle leaders of mathematics in primary and secondary schools?
- How are the goals of middle leaders aligned to the activities of middle leaders of mathematics?

The study

This study used survey methods. It is part of the *Numeracy Leaders' Needs Analysis* (Vale et al. 2020) designed to identify the activities, knowledge, wishes, goals,

challenges and professional learning needs of SMLs in Victorian primary and secondary schools and to seek their preferences for their professional learning. It was distributed electronically to principals of all primary and secondary public schools in Victoria who were asked to pass on the link to the questionnaire to their SML. SMLs could also access the online questionnaire through at Department of Education website. In this article, we report findings with respect to the goals and the activities of SMLs.

Participants

One hundred and ninety-six (196) teachers responded to the questionnaire. The majority (71%) of respondents worked in primary schools and about a quarter (23%) were in secondary schools. This breakdown approximately corresponds to the proportion of public primary and secondary schools in Victoria (69% and 31% respectively). The other participants (6%) included leaders or teachers working in, or with, Special Education schools or with networks of schools. Almost all (86%) participants identified themselves as SML. The other participants included principals[1] (3), assistant principals (2), sub-school leader (1), team leaders for more than one year level (4), numeracy specialists (2), learning specialists (6), coach (1), primary mathematics specialist (1) or teachers (6). Some of the teachers indicated their aspiration to lead mathematics in their school.

Participants worked in schools from across the state, including large metropolitan schools, regional schools, and small rural and remote schools. The primary schools ranged from small rural schools with less than 50 students to large schools with more than 1000 students. The median primary school was between 301 and 400 students with between 11 and 20 classroom teachers. Secondary schools varied in size from less than 100 students to more than 1000 students with a median size of 500–1000 students and between 6 and 10 mathematics teachers.

Data collection

The questionnaire gathered responses from SMLs online via Qualtrics. It included 24 items with a mixture of Likert, ranking, multiple choice, and open-ended items. Open-ended items gathered information about mathematics leaders' wishes, goals, and challenges. In this article, we analysed the goals of SMLs using the open item about their goals:

> Question 5: As a leader of mathematics, your three key goals over the next three years are …

We collected and analysed the activities of SMLs using three Likert items to record frequencies of various leadership activities that were grouped to

reflect the main contexts in which middle leaders work (Grootenboer, Edwards-Groves, and Rönnerman 2015) including:

Question 1. Leadership in the classroom (7 sub-items – Likert scale)

Question 2: Leadership beyond the classroom (12 sub-items – Likert scale)

Question 3: Managing and administration (4 sub-items – Likert scale)

The sub-items for each of these questions were designed using findings from previous studies (Clarke et al. 2005; Driscoll 2017; Masters 2010; Author et al., 2014) and used a seven-point Likert scale from 'Not at all' (1) to 'Very often' (7). For example, 'in the classroom activities' included activities other than their teaching such as modelling mathematics lessons, co-planning an individual lesson with a classroom teacher, analysing and discussing student work, and observing and talking with students about their learning and providing feedback for the teacher. Leadership activities 'beyond the classroom' included activities such as mentoring and facilitating various meetings for planning, assessment or professional learning. Additional closed items were used to gather demographic data including the time allocated per week for SMLs to perform their role.

Data analysis

A phenomenological approach similar to that described by Moustakas (1994) was used to identify themes in the responses to the open-ended item about goals (Q5). SMLs' responses concerning their goals were analysed by assigning them to six broad categories that emerged from the initial reading of the data: Students, Teachers, Teaching and learning, Resources, Leadership, and Community involvement. Subcategories of each main theme were then described (see discussion of results for the respective sub-categories). The coding was led by a concept-driven approach initially, and data-driven coding thereafter to determine the sub-categories (Charmaz 2008; Gibbs 2018). This process involved initial coding by Roche, which was then verified by Cheeseman and Downton.

The goals were then analysed to establish if a 'dominant theme' could be identified across the three goals reported by each participant. This was achieved by first adding the points assigned to each sub-category for each main theme. Secondly, the main theme that had the highest number of points was taken to be that participant's 'dominant theme'. If no theme had a unique highest value, then that participant was coded as having 'no dominant theme'. For example, Table 1 provides the results for three participants. Participant 35 was assigned three points for 'Teaching and learning' and none for any other theme, therefore, 'Teaching and learning' was their dominant theme. Similarly, Participant 36 was assigned two points for 'Students' and one point for 'Teaching and learning' so was assigned 'Students' as their dominant theme. Participant 37 was assigned one point each for 'Teachers,' 'Teaching and learning' and 'Leadership'

Table 1. Examples of assigning points for three participant's three goals to a main theme.

#ID		Students	Teachers	Teaching and learning	Resources	Leadership	Community involvement
35	Coaching staff to reach individual goals Developing data literacy and implementing this in planning Developing clear proficiency scales matching curriculum for all maths strands	0	0	3	0	0	0
36	Improve the NAPLAN data analysis and results All students from 7 to 10 learning at their appropriate level whether it be above or below their current year level standard Have a solid program in place at our school for peer observations, team teaching and coaching	2	0	1	0	0	0
37	Improve assessment tools Develop numeracy across non maths subjects Develop pedagogy knowledge of maths teachers	0	1	1	0	1	0

and hence was assigned as having 'no dominant theme'. Using this method, the overall results indicated that 76% of participants had a dominant theme.

Means and standard deviations were calculated for the Likert items concerning the activities for all SMLs, for each category of activities, and for each group of SMLs according to the dominant theme of their goals. As the Likert items used a scale of 1–7, activities for which the mean response for the group was greater than 4.5 were considered high frequency for a group and used to illustrate the most frequent type of activity in that context. To explore the alignment of goals and activities descriptive statistics were used to identify similarities and differences in mean scores for each category of activities according to the dominant theme of SML's goals.

Findings

In this section, we start by providing some further information on the teaching and leadership experience and time allocation for leadership roles before

reporting on the goals and activities of SMLs. Then we consider whether the dominant theme of the goals of SMLs influences the frequency with which the activities were undertaken in different contexts and frequencies of particular activities that align with the different dominant themes describing their goals.

Teaching and leadership experience of participants

It was important to understand the extent of the participants' teaching and leading experience as these factors may influence their goals and activities as SMLs (see Table 2). Almost all, 99% of primary SMLs and secondary SMLs responding to the survey had more than three years of teaching experience. However, 30% of primary SMLs and 23% of secondary SMLs had been leading mathematics in their school for less than one year. A higher proportion of secondary SMLs than primary SMLs had been leading mathematics for more than three years (33% compared to 22%).

With regard to the time allocated for their role as SML, many primary and secondary SMLs were provided less than two hours per week to complete their leadership activities (42% and 50%, respectively) (see Table 3). This may relate to the size of their school and number of teachers to lead and, or their responsibilities as perceived by the Principal.

Goals of school mathematics leaders

SMLs' goals were coded to six major categories: Teaching and learning, Students, Leadership, Teachers, Resources, Community Involvement, and sub-categories of the goals were also defined (Table 4). Almost half the goals focused on teaching and learning (45%). This finding acknowledges that to improve students' mathematical outcomes, teaching and the resultant learning goals need to be considered. The next most frequent responses related to students (20%); followed by leadership (17%); teachers (14%); resources (2%); and community involvement (2%). These major categories also indicate who the SML will interact with to achieve shared understandings, that is, teachers and students, school leadership and the school community. Next, each of these categories of goals will be described briefly.

Table 2. Number of years teaching and leading mathematics.

	Teaching ($n = 196$)		Leading mathematics ($n = 167$)	
	Primary *n* (%)	Secondary n (%)	Primary *n* (%)	Secondary *n* (%)
Less than 1 year	1 (0.7)	0 (0)	39 (30.4)	9 (23.0)
1–3 years	1 (0.7)	1 (2.2)	55 (42.9)	15 (38.4)
4–9 years	44 (29.3)	17 (37.0)	28 (21.9)	10 (25.6)
10–15 years	34 (22.7)	13 (28.3)	3 (2.3)	4 (10.3)
Longer than 15 years	70 (46.7)	15 (32.6)	3 (2.3)	1 (2.6)

Table 3. Number of hours per week allocated for the SML role (Q17).

	Primary SMLs, *n* (%)	Secondary SMLs, *n* (%)
0 h	28 (18.7)	7 (15.2)
<2 h	35 (23.3)	16 (34.8)
2.1–4 h	16 (10.7)	9 (19.6)
4.1–6 h	13 (8.7)	9 (19.6)
6.1–8 h	8 (5.3)	2 (4.3)
8.1–10 h	10 (6.7)	1 (2.2)
10.1–20 h	33 (22.0)	2 (4.3)
>20 h	8 (5.3)	0 (0.0)

Teaching and learning

Detailed analysis of the goals concerning teaching and learning ($n = 290$) revealed that the shared understanding that SMLs aimed to develop principally concerned teachers' pedagogical practices ($n = 103$), and assessment and data analysis ($n = 91$). For example, 'promote problem solving and encourage reasoning' and 'embed formative assessment.' Illustrative examples of goals for each subcategory are shown in Table 4. Overall, the SMLs' goals aligned with the view that improving teachers' pedagogical and assessment practices were key to achieving improved learning outcomes for students. We would argue that goals pertaining to collaboration, planning, and professional learning are

Table 4. Frequency of goal statements for leaders ($n = 637$).

Categories	Goals *n* (%)	Quotes as examples
Teaching and learning		
Pedagogy	103	Promote problem-solving skills and encourage reasoning
Assessment data	91	To embed formative assessment practices
Collaboration	41	Co-teaching and planning, opportunities, and ongoing reflections
Lesson/task types	33	Facilitate engaging lessons with real-life connections
Planning	22	Overhaul maths planning
Total	290 (45%)	
Students		
Learning outcomes	62	For all students to experience significant growth
Dispositions/agency	47	Increase student agency. To build students engagement with learning mathematics
Extension/interv'n	15	Improve intervention and extension.
Total	124 (20%)	
Leadership		
Whole school approach	101	To work towards having a consistency of approach in the teaching of mathematics
Leaders' capacity to lead	10	Develop my own capacity to lead effective change school wide
Total	111 (17%)	
Teachers		
Knowledge mathematics	53	Build capacity and knowledge in all areas of mathematics
Knowledge curriculum	17	Improve knowledge of the learning continua
Disposition/mindset	13	Staff to feel confident and passionate about teaching maths
Beliefs/capabilities	5	Develop self-belief about teaching maths
Total	88 (14%)	
Resources		
Teaching materials	9	Resourcing the needs to the school
Professional learning	4	Support staff with timely professional learning
Total	13 (2%)	
Community involvement	11	Engage families and community in maths
Total	11 (2%)	

means of achieving improved pedagogies. They also indicate the nature of activities and relationships involved in enacting the goals to develop shared understandings.

Students

The most common foci of the goals relating to students ($n = 124$) were: student learning outcomes ($n = 62$, 50%), disposition or agency ($n = 47$, 38%), for example, 'to build student engagement.' Far less frequently listed were goals relating to intervention, support or extension programs ($n = 15$, 12%). Goals relating to student learning outcomes ($n = 62$) focused mainly on growth, for example, 'to improve student mathematics learning outcomes.' Other goals specified achievement on National tests, student goal setting, and problem-solving capabilities. In mathematics lessons, goals about student disposition focused on self-belief, confidence, positive mindset, and student voice and agency (see Table 4). These goals provide little indication of the activities that the SMLs will do and with whom they will conduct these activities.

Leadership

Only 17% ($n = 111$) of respondents' goals related to leadership. However, a closer examination revealed that the majority (91%) of leadership goals focused on 'having a consistency of approach in the teaching' and shared philosophy that is, shared understandings and practices, towards the teaching and learning of mathematics. In addition, SMLs' goals included: developing a culture that reflected the importance of mathematics that is, shared values, and improving their own capacity as a leader. Again, these goals indicate the need to engage with all teachers, they do not suggest what they will do to achieve these goals.

Teachers

SMLs with the dominant goal concerning teachers recognised the importance of developing shared understanding and practice ($n = 88$; 14%). Developing teacher knowledge of mathematics was a priority ($n = 53$). In addition, curriculum knowledge ($n = 17$), teacher attitudes and beliefs ($n = 18$) were also considered. SMLs recognised the importance of building teachers' mathematics knowledge for teaching and their dispositions towards mathematics, for example 'to develop self-belief about teaching maths'. One would expect that the SMLs who expressed these goals would need to be relating with individual teachers but it is not clear what they would do with these teachers.

Resources and community involvement

A very small proportion (2%) of respondents' goals related to materials and professional learning resources. SMLs articulated a need for more time to provide professional development and resources for teachers. Few goals (2%) related

to community involvement. However, these goals expressed the need to share values that build greater awareness of mathematics and raise the profile of mathematics.

Dominant themes in the goals of school mathematics leaders

The results of the analysis of SMLs' goals to determine a dominant theme are shown in Table 5. Overall, 76% of leaders had a dominant theme across their goals. Only one SML had a dominant theme categorised as *resources* and no one had a dominant theme categorised as *community involvement*. These results are not unusual given that there were few subcategories for both themes, making it unlikely they would be assigned more than one point for each theme. There were some differences identified between primary and secondary SMLs. There was a higher proportion of primary SMLs with no dominant theme in their goals, and a dominant goal related to *teaching and learning*, whereas secondary SMLs were more likely to have a dominant goal pertaining to *leadership* or *students*. The analysis of the goals provides some indication of who the SMLs may be relating with to enact these goals, for example, students, teachers or school leaders, however, their goals give a little indication for the nature of the activities that they will undertake. The next section presents findings about the frequency of leadership activities.

Activities of school mathematics leaders

In this section, we report findings for three items that asked SMLs to identify the amount of time spent on leading mathematics from within the classroom, beyond the classroom and through administration and management activities (Tables 6–8). Overall, the mean amount of time that SMLs spent doing leadership activities inside the classroom ($m = 4.07$, $SD = 3.7$) and beyond the classroom ($m = 4.01$, $SD = 3.1$) was roughly the same. Slightly less time was spent doing administration and management ($m = 3.99$, $SD = 0.1$) but there was less variation in time spent by SMLs on these activities. First, we report on the most frequent activities for all SMLs and then report on the activities of SMLs and relate these activities to the dominant theme of their goals.

Table 5. Number of SMLs assigned to each dominant theme across their three goals.

Dominant theme across three goals	All ($n = 194$)	Primary ($n = 148$)	Secondary ($n = 46$)
No dominant theme	47 (24%)	39 (26%)	8 (17%)
Students	20 (10%)	12 (8%)	8 (17%)
Teachers	11 (6%)	7 (5%)	4 (9%)
Teaching and Learning	92 (47%)	75 (51%)	17 (37%)
Resources	1 (1%)	1 (1%)	0 (0%)
Leadership	23 (12%)	14 (9%)	9 (20%)
Community involvement	0 (0%)	0 (0%)	0 (0%)

Table 6. Leading mathematics in the classroom (Q1) for all SMLs and each dominant theme in their goals (mean and standard deviation).

Leading activities	All ($n = 196$)	L & T ($n = 92$)	No dom ($n = 47$)	Lea'ship ($n = 23$)	Students ($n = 20$)	Teachers ($n = 11$)
Model mathematics lessons for other teachers	3.73 (1.9)	3.99 (1.8)	3.72 (1.9)	2.91 (1.7)	3.60 (2.0)	3.73 (2.0)
Co-plan individual mathematics lessons with classroom teacher(s)	4.49 (1.9)	4.95 (1.8)	4.19 (2.1)	3.52 (1.8)	4.55 (2.0)	4.09 (2.1)
Collect, analyse and discuss student work samples with the classroom teacher	4.14 (1.7)	4.24 (1.7)	4.13 (1.8)	3.74 (1.5)	4.20 (2.0)	4.00 (1.9)
Co-teach mathematics alongside teachers and review lesson	3.53 (2.0)	3.72 (2.0)	3.66 (2.0)	2.74 (1.5)	3.70 (2.2)	2.91 (1.8)
Observe and talk with students about their learning during mathematics lessons and provide feedback for the teacher	3.96 (2.0)	4.11 (2.0)	3.87 (2.1)	3.48 (2.1)	3.85 (1.9)	4.27 (2.3)
Talk to students about their learning during a mathematics lesson	5.14 (1.9)	5.07 (2.0)	5.26 (1.9)	4.74 (1.9)	5.40 (1.8)	5.91 (1.4)
Teach small groups of students for intervention or extension	4.00 (2.3)	4.07 (2.3)	3.91 (2.3)	4.39 (2.2)	3.65 (2.6)	3.45 (2.2)
Leading mathematics in the classroom *M* (SD)	4.07 (3.7)	4.30 (0.4)	4.08 (0.7)	3.65 (1.8)	4.14 (0.2)	4.05 (0.7)

Activities of SMLs in the classroom.

The mean frequencies of time spent by SMLs doing leadership activities in the classroom are shown in Table 6. The most frequently reported activity was 'Talk to students about their learning during a mathematics lesson' ($m = 5.14$, SD = 1.9). This finding is not surprising as 85% of all leaders continued to have teaching responsibilities. However, the way in which they used these conversations with students in their role as a leader is unknown. The next most common activity was to 'Co-plan individual mathematics lessons with classroom teacher(s)' ($m = 4.49$, SD = 1.9). The least frequent activities for all SMLs were 'Co-teach mathematics alongside teachers and review lesson' ($m = 3.53$, SD = 2.0) and 'Model mathematics lessons for other teachers' ($M = 3.73$, SD = 1.9).

Activities of SMLs beyond the classroom.

The most frequent activity for SMLs when leading outside the classroom was 'Participate in team mathematics planning meetings' ($m = 4.72$, SD = 1.9, see Table 7). This finding fits with their tandem role as classroom teachers but also provides an opportunity to develop shared meanings and understandings. Other frequent activities included 'Facilitate or conduct professional learning for teachers of mathematics' ($m = 4.72$, SD = 1.9) and 'Mentor teachers of mathematics' ($m = 4.62$ SD = 2.0).

Managing and administration.

Of the four items that asked SMLs about their management and administration activities (Table 8) 'Manage access to and purchasing of mathematics resources' ($m = 5.23$, SD = 2.0) was conducted most frequently. Each of these activities was

Table 7. Leading mathematics beyond the classroom (Q2) by all SMLs and each dominant theme in their goals (mean and standard deviation).

Leading activities	All ($n = 196$)	L & T ($n = 92$)	No dom ($n = 47$)	Lea'ship ($n = 23$)	Students ($n = 20$)	Teachers ($n = 11$)
Mentor teachers of mathematics.	4.62 (2.0)	4.85 (1.8)	4.62 (2.0)	3.43 (2.1)	4.90 (1.9)	5.18 (2.0)
Facilitate or conduct professional learning for teachers of mathematics	4.72 (1.9)	4.78 (1.8)	5.13 (1.8)	3.70 (1.8)	4.60 (2.2)	5.36 (1.5)
Participate in team mathematics planning meetings	5.15 (2.0)	5.28 (1.9)	5.13 (1.9)	4.52 (2.4)	5.10 (2.1)	5.73 (1.4)
Facilitate meetings for assessment moderation	4.07 (2.0)	4.35 (1.8)	3.83 (2.0)	3.22 (1.9)	3.95 (2.4)	4.64 (1.9)
Facilitate formative assessment meetings to analyse student work	3.71 (1.9)	3.86 (1.8)	3.68 (2.1)	3.52 (2.0)	3.30 (2.1)	3.64 (2.1)
Facilitate meetings to analyse assessment data to refine and adjust curriculum based on identified needs of students	4.25 (1.8)	4.51 (1.6)	4.13 (2.0)	3.70 (1.7)	3.90 (2.1)	4.55 (1.8)
Design and lead mathematics assessment programs in the school	4.43 (1.9)	4.62 (1.7)	4.60 (2.0)	3.65 (2.1)	4.05 (2.2)	4.91 (1.9)
Engage parents and community in the school's mathematics programme	2.84 (1.6)	2.86 (1.7)	2.98 (1.6)	2.30 (1.6)	3.10 (1.6)	2.82 (1.4)
Facilitate meetings to evaluate strengths, weaknesses, and opportunities for improving teaching of mathematics/numeracy	4.07 (1.9)	4.16 (1.8)	4.11 (1.8)	3.39 (1.9)	3.95 (2.2)	4.91 (1.4)
Lead the design of goals for improving mathematics/numeracy teaching	4.42 (2.0)	4.53 (1.9)	4.32 (1.9)	3.87 (2.0)	4.30 (2.3)	5.36 (2.1)
Mentor teachers about opportunities for numeracy learning in other subjects	3.34 (1.8)	3.47 (1.8)	3.49 (1.9)	2.52 (1.5)	2.95 (1.9)	4.27 (1.8)
Participate in a network of mathematics/numeracy leaders	3.26 (2.0)	3.34 (2.0)	3.68 (2.0)	2.70 (1.8)	2.40 (2.0)	3.45 (1.9)
Leading mathematics beyond the classroom *M* (SD)	4.01 (3.8)	4.22 (0.4)	4.10 (0.1)	3.38 (1.4)	3.88 (0.8)	4.57 (0.9)

conducted more frequently than many of the leadership activities conducted in and beyond the classroom.

The alignment of goals and activities of SMLs

In order to investigate the alignment of the reported goals and activities for each group of SMLs with the same dominant theme in their goals we calculated

Table 8. Managing and administration (Q3) for all SMLs and each dominant theme in their goals (mean and standard deviation).

Leading activities	All ($n = 196$)	L & T ($n = 92$)	No dom ($n = 47$)	Lea'ship ($n = 23$)	Students ($n = 20$)	Teachers ($n = 11$)
Organise professional learning facilitated by external experts	3.16 (1.9)	3.41 (1.9)	2.91 (1.8)	2.48 (1.6)	3.40 (2.0)	3.64 (2.6)
Manage access to and purchasing of mathematics resources	5.23 (2.0)	5.28 (2.0)	4.96 (1.9)	4.96 (2.0)	5.80 (1.9)	5.64 (1.7)
Timetable and organise allocated planning time (APT)	3.19 (2.3)	3.16 (2.4)	2.51 (1.9)	3.43 (2.3)	3.90 (2.4)	4.91 (2.2)
Manage mathematics assessment programmes	4.56 (2.0)	4.61 (1.9)	4.30 (2.0)	4.04 (2.2)	4.95 (2.0)	6.00 (1.3)
Managing and administration *M* (SD)	3.99 (0.4)	4.12 (1.4)	3.63 (1.3)	3.73 (2.8)	4.51 (1.1)	5.05 (1.4)

the mean and standard deviation for the three categories of activities: in the classroom, beyond the classroom, and administration and management (see Tables 6–8, at the end of the paper). We used descriptive analysis to compare the mean scores for each category of activities for each of dominant theme of goals of SMLs.

Aligning goals to activities in the classroom

SMLs whose dominant theme for their goals was 'learning and teaching' (47% of participants) recorded the highest mean score for activities involving leading in the classroom ($m = 4.30$, SD = 0.4). This finding confirms that SMLs who are focussed on developing shared understandings of pedagogies, assessment, task design, planning and collaboration spend much of their time leading in the classroom. For example, high mean scores for classroom activities for this group of SMLs were recorded for 'co-planning individual mathematics lessons with classroom teacher(s)' ($m = 4.95$, SD = 1.8).

Likewise, SMLs whose dominant theme was 'students' (10% of participants) and focussed on improving student outcomes, dispositions and engagement and providing extension or intervention, also spent much of their time leading in the classroom ($m = 4.14$, SD = 0.2) with their most frequent doing 'talking to students about their learning during a mathematics lesson' ($m = 5.40$, SD = 1.8).

Aligning goals to activities beyond the classroom

The highest mean score for activities involving leading beyond the classroom was for the group of SMLs with a dominant theme concerning 'teachers' (6% of participants, $m = 4.57$, SD = 0.9). SMLs in this group were aiming to improve teachers' knowledge of the curriculum and teaching as well as improve their capabilities and mindsets. The activities beyond the classroom with the highest frequencies for this group of SMLs were 'participate in team mathematics planning meetings' ($m = 5.73$, SD = 1.4), 'facilitate or conduct professional learning for teachers of mathematics ($m = 5.36$, SD = 1.5), 'lead the design of goals for improving mathematics/numeracy teaching ($m = 5.36$, SD = 2.1).

The 'learning and teaching' group recorded the next highest mean ($m = 4.22$, SD = 0.4) for leadership activities beyond the classroom. This group of SMLs reported working with teachers beyond the classroom to develop shared understandings of teaching and learning by 'participating in team mathematics planning meetings' ($m = 5.28$, SD = 1.9), 'mentoring teachers of mathematics' ($m = 4.85$, SD = 1.8) and 'facilitating or conducting professional learning for teachers of mathematics' ($m = 4.78$, SD = 1.8).

Aligning goals to administration and management activities

Somewhat surprisingly, the highest mean score for activities involving managing and administrating was recorded for SMLs with a dominant theme of

'teachers' ($m = 5.05$, SD = 1.4). It is unclear why this group spends the highest amount of time on managing administering, in particular, 'administering assessment programs' ($m = 6.00$, SD = 1.3).

The SMLs with the dominant theme of 'students' (10% of participants) also recorded a high mean for this category of activities ($m = 4.51$, SD = 1.1). Their focus on improving student growth and dispositions, likely lead them to spend time 'managing assessment programs ($m = 4.95$, SD = 1.1). Surprisingly, leaders in this group were not frequently involved in activities such as developing goals for improving mathematics learning and teaching or providing feedback for teachers. It might be expected that the SMLs with the dominant theme of leadership would have recorded higher mean frequencies.

The activities of leaders with diverse themes in their goals

Many leaders (24%) who did not have a dominant theme across their goals, but three distinct foci, demonstrated the diverse nature of the shared understandings and practices they aimed to develop. The leaders in this *no dominant theme* group recorded similar mean times for leading in the classroom as leading beyond the classroom. Overall, the diverse *activities* of this group aligned with the diverse nature of their *goals*. Surprisingly this group, rather than the leadership group had the highest frequency of 'participating in a network of mathematics/numeracy leaders' ($m = 3.68$, SD = 2.0).

In summary, the *activities* and *goals* of SMLs were well aligned for three groups: leaders focused on developing shared understandings of *learning and teaching*; leaders focused on developing shared understandings among *teachers;* and leaders with diverse goals (*no dominant theme*).

Discussion

The analysis of the SMLs' goals painted a picture of the shared understandings and practices that SMLs aimed to develop or improve in their schools. Two dominant themes were evident from these results. Firstly, developing a shared understanding of mathematics *learning and teaching,* and secondly developing practices to improve *students'* learning outcomes. Goals and activities of SMLs were best aligned when the dominant theme in leaders' goals was *learning and teaching* or *teachers.* Teacher knowledge and attitudes were the understandings and practices that this third group of SMLs were focussed on. Hence the alignment of their goals and activities suggests that these two groups of leaders appreciated the relationship between improving *mathematics* teaching, and improving students' mathematics learning (Ball, Thames, and Phelps 2008; Hattie 2002). Further alignment for the goals and activities of SMLs that were focussed on *teachers* may have been revealed had the questionnaire identified classroom activities such as coaching and co-teaching (Driscoll 2017; Sexton 2019).

When the dominant theme in leaders' goals was students, their high-frequency leadership activities were mostly focused on teachers. Although this finding might be explained by leaders appreciating that improving teaching leads to improved learning, this group may be less clear about this relationship. Indeed, their leadership might be more effective if their goals were focused more directly on teachers and teaching.

A surprising finding was the misalignment of the goals and activities of the group of leaders with leadership as the dominant theme in their goals. This group wanted to enact a school vision of mathematics teaching and learning as identified in previous studies (e.g. Vale et al. 2010). However, the high-frequency activities of this group were not strongly aligned with high-impact leadership activities (Driscoll 2021; Masters 2010; Sexton 2019). Leaders belonging to this group may not be aware of the type of leadership activities that best improve mathematics learning and teaching.

This group of leaders with leadership as their dominant theme also aimed to improve their limited leadership skills and self-efficacy. We noted that the majority of SMLs participating in this study had less than 3 years of experience in their role and more than a quarter with less than one year in the role. Other studies have reported that SMLs' lack of mathematics knowledge and confidence can impact on their ability to enact their role (Clarke et al. 2005; Gaffney and Faragher 2010), or lack of self-efficacy to lead (Driscoll 2017). Perhaps this suggests limited experience in the role, such as that noted in our sample of SMLs.

An important finding in this study was that the high-frequency activities of SMLs were seldom leadership activities that focused directly on high-impact leadership activities such as collaboratively designing goals for improving mathematics teaching (Sexton 2019), refining, and adjusting curriculum based on student needs (Clarke et al., 2005), or providing feedback for teachers following activities such as co-teaching (Driscoll 2021). Many leaders were engaged in low-impact leadership activities such as talking to students during lessons, participating in planning, and managing access to resources. Engagement in these classroom activities enables SMLs leaders to stay connected to the classroom for building trust and collegial credibility (Grootenboer, Edwards-Groves, and Rönnerman 2015; Kemmis et al. 2014). However, the high frequency of these activities compared to other in classroom and beyond classroom activities may be due to SMLs' lack of leadership experience or expertise, lack of time to plan and enact leadership activities, or lack of opportunities for their own professional learning. For example, few SMLs reported frequent participation in networks for SMLs.

Previous studies have indicated that the cultural-discursive arrangements, material-economic and socio-political contexts of their school (Grootenboer, Edwards-Groves, and Rönnerman 2015; Kemmis et al. 2014) can constrain SMLs in enacting their goals (Wilkie and Tan 2019). However, we did not report on constraints to SMLs goals and activities (Downton et al. 2022 regarding the

challenges faced by this cohort of SMLs). In this study, the material-economic arrangements may be evident in the less frequent time spent by SMLs in the classroom teaching alongside, modelling, or observing teachers.

Conclusion

SMLs are engaged in a range of activities both inside and beyond the classroom. The goals and activities are most closely aligned when the goals concern teaching and learning and the activities involve engagement with students and teachers in the classroom or team planning meetings. It is likely that SMLs would benefit from professional learning, and more dedicated time allocation, in order to better lead their school communities towards more effective mathematics learning and teaching.[2] This would include developing their leadership knowledge to better align goals and activities to develop distinctive relevant practices such as co-planning co-teaching and co-reflecting, demonstration lessons, formative assessment and planning, and action research (Vale et al. 2010; Driscoll 2017; Lipscombe, Tindall-Forde, and Grootenboer 2019; Sexton 2019; Sullivan 2020). Further research is recommended to gain insights into why the goals and frequent activities of SML are not well aligned, and to determine whether this impacts the effectiveness of their mathematics leadership.

We recognise that there are several weaknesses in this study. Firstly, analysis of the connection between goals and activities would hold more validity and reliability had the survey instrument been designed to use closed items for goals. Some highly effective practices, such as action research (Grootenboer, Edwards-Groves, and Rönnerman 2020; Lipscombe, Tindall-Forde, and Grootenboer 2019; Masters 2010) and teaching alongside (Driscoll, 2019) were not included as possible leadership activities. Also, the frequency of doing these activities was measured using an abstract scale of 1–7 rather than indicating how often these activities were done, such as daily, weekly, monthly, each term or yearly. There was a small number of SMLs with a lot of time for this role, or who were very experienced, and we have not analysed and compared their goals and activities with the less experienced and time-poor SMLs. These weaknesses identify opportunities for further research. We also recommend further research to learn more about how SMLs' goals are enacted through their activities and how they contribute to improving the teaching and learning of mathematics in primary and secondary schools.

Notes

1. In small rural schools in Victoria, the school principal may also be the SML.
2. Professional learning programs based on the findings from Numeracy Needs Analysis have been enacted by the researchers with the Victorian Academy of Teaching and Leadership. (https://www.education.vic.gov.au/about/department/Pages/vatl.aspx).

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

The project was funded by the Victorian Academy of Teaching and Leadership, Department of Education and Training Victoria, Australia.

Notes on contributors

Colleen Vale is Professor of Mathematics Education at Monash University. She has an ongoing research interest in equity and social justice. Her current research projects concern school mathematics leadership and an Australian Research Council (ARC) Discovery Project about developing teachers' adaptive expertise. She has numerous research publications about the teaching, learning and assessment of mathematical reasoning, the use of Japanese Lesson Study for teacher learning, and the experiences and practices of out-of-field secondary mathematics teachers. She is co-author of the award-winning book: Teaching Secondary School Mathematics: Research and practice for the 21st century.

Anne Roche is a mathematics education researcher in the Faculty of Education at Monash University. Her initial research interest concerned the teaching and learning of fractions and decimals in primary classroom and this field is an ongoing research focus. Over the years' she has worked on a range of mathematics teaching and learning research projects including pedagogies to improve the engagement and learning of low achieving students, differentiating instruction, students' multiplicative thinking and the goals and practices of school mathematics leaders.

Jill Cheeseman is a senior lecturer in the Faculty of Education at Monash University. Jill's research interests centre on how children learn mathematics and how teachers challenge children's mathematical thinking. Her current research is about challenging young children's multiplicative thinking. She has also conducted research and published research findings on challenging children's measurement thinking. She also continues to conduct research in school mathematics leadership that she commenced during an earlier project, the Early Numeracy Project, which won a Mathematics Education Research Group of Australasia (MERGA) Research Award.

Ann Gervasoni is an Associate Professor of numeracy in the Faculty of Education at Monash University. Her research is focused on enhancing the learning of children who are vulnerable in learning mathematics. She developed the research-based Extending Mathematical Understanding Intervention Program that is used across three states in Australia. She also works with NSW School Principals and Mathematics Leaders across 150 schools engaged in a project focusing on system-wide reform of mathematics learning and teaching. Through this project and others, Ann has developed research expertise in practices and influence of school leadership and mathematics leaders in schools.

Sharyn Livy is a senior lecturer of mathematics education in the Faculty of Education at Monash University. Her research interests are closely linked to her teaching and involve supporting primary pre-service teachers and practicing primary teachers to extend their knowledge for mathematics teaching. Other research interests include implementation of sequences of challenging tasks, geometric reasoning and engaging children with mathematics through picture storybooks. Sharyn recently completed an Australian Research Council

(ARC) Linkage project with colleagues to provide school mathematics leaders and teachers with strategies and tools to improve student learning in the early years.

Ann Downton is a senior lecturer of mathematics education in the Faculty of Education at Monash University. Ann's initial research involved enhancing teachers' pedagogical content knowledge to improve student learning. This involved supporting school mathematics leaders and developing their skills and expertise as leaders of school based professional learning. She recently completed Australian Research Council (ARC) Linkage project with colleagues to provide school mathematics leaders and teachers with strategies and tools to improve student learning in the early years. Ann's main research interest concerns primary students' multiplicative thinking. She has published numerous studies of the strategies students in Years 3 and 4, and more recently Years 1 and 2, use to think multiplicatively and the pedagogical and curriculum implications for teachers.

References

Australian Institute for Teaching and School Leadership. 2017. "Professional Standards for Teachers." https://www.aitsl.edu.au/teach/standards.

Ball, D. L., M. H. Thames, and G. Phelps. 2008. "Content Knowledge for Teaching: What Makes it Special?" *Journal of Teacher Education* 59: 389–407. doi:10.1177/0022487108324554

Borko, H., J. Carlson, R. Deutscher, et al. 2021. "Learning to Lead: An Approach to Mathematics Teacher Leader Development." *International Journal of Science and Mathematics Education* 19: 121–143. doi:10.1007/s10763-021-10157-2.

Calderone, S., A. M. Kent, and A. M. Green. 2018. "Teacher Leaders and Student Achievement: Can the Dots Be Connected?" *Revista Eletrônica de Educação* 12 (2): 395–407. doi:10.14244/198271992525

Charmaz, K. 2008. "Grounded Theory as an Emergent Method." In *Handbook of Emergent Methods*, edited by S. N. Hesse-Biberand, and P. Leavy, 155–170. New York, NY: Guilford Press.

Clarke, D., M. Stephens, G. Lewis, and A. Downton. 2005. "The Evaluation of the Success in Numeracy Education Program." In *Building Connections: Research, Theory and Practice*, edited by P. Clarkson, A. Downton, D. Gronn, M. Horne, A. McDonough, R. Pierce, and A. Roche, 257–280. Mathematics Education Research Group of Australasia. https://merga.net.au/Public/Publications/Annual_Conference_Proceedings/2005_MERGA_CP.aspx.

De Nobile, J. 2018. "Towards a Theoretical Model of Middle Leadership in Schools." *School Leadership and Management* 38 (4): 395–416. doi:10.1080/13632434.2017.1411902.

Department of Education and Training. 2020. *FISO Strategic Enablers for Implementation Guide*. https://www.education.vic.gov.au/PAL/fiso-strategic-enablers-for-implementation-guide.pdf.

Department of Education and Training. 2022. *Primary Mathematics and Science Specialists Initiative*. https://www2.education.vic.gov.au/pal/student-resource-package-srp-targeted-initiatives/guidance/primary-mathematics-and-science.

Downton, A., J. Cheeseman, and A. Roche. 2022. "Goals and the Challenges of School Mathematics Leaders." *Mathematics Teacher Education and Development* 24 (1): 96–115. https://mted.merga.net.au/index.php/mted/issue/view/60.

Driscoll, K. 2017. “Primary School Mathematics Leaders’ Views of Their Mathematics Leadership Role.” In *40 Years on: We are Still Learning!*, edited by A. Downton, S. Livy, and J. Hall, 213–220. Melbourne: Mathematics Education Research Group of Australasia. https://merga.net.au/Public/Publications/Annual_Conference_Proceedings/2017_MERGA_annual_conference_proceedings.aspx.

Driscoll, K. 2021. "An Investigation of the Ways in Which School Mathematics Leaders Support Primary Teachers’ Professional Learning." PhD, Monash University, Melbourne, Australia.

Farchi, T., and D. Tubin. 2019. “Middle Leaders in Successful and Less Successful Schools.” *School Leadership and Management* 39 (3-4): 372–390. doi:10.1080/13632434.2018.1550389.

Gaffney, M., and R. Faragher. 2010. “Sustaining Improvement in Numeracy: Developing Pedagogical Content Knowledge and Leadership Capabilities in Tandem.” *Mathematics Teacher Education and Development* 12 (2): 72–83. https://mted.merga.net.au/index.php/mted/issue/view/10.

Ganon-Shilon, S., and C. Schechter. 2017. “Making Sense of School Leaders’ Sense Making.” *Educational Management Administration and Leadership* 45 (4): 682–698. doi:10.1177/1741143216628536.

Gibbs, G. R. 2018. *Analyzing Qualitative Data*. 2nd ed. Los Angeles, CA: Sage Publications.

Grootenboer, P., C. Edwards-Groves, and K. Rönnerman. 2015. “Leading Practice Development: Voices from the Middle.” *Professional Development in Education* 41 (3): 508–526. doi:10.1080/19415257.2014.924985.

Grootenboer, P., C. Edwards-Groves, and K. Rönnerman. 2020. *Middle Leadership in Schools: A Practical Guide for Leading Learning*. New York, NY: Routledge.

Hattie, J. A. C. 2002. “What Are the Attributes of Excellent Teachers?” In *Teachers Make a Difference: What is the Research Evidence?*, edited by B. Webber, 3–26. Wellington: New Zealand Council for Educational Research.

Higgins, J., and L. Bonne. 2011. “Configurations of Instructional Leadership Enactments That Promote the Teaching and Learning of Mathematics in a New Zealand Elementary School.” *Educational Administration Quarterly* 47 (5): 794–825. doi:10.1177/0013161X11413763.

Hjalmarson, M. A., and C. K. Baker. 2020. “Mathematics Specialists as the Hidden Players in Professional Development: Researchable Questions and Methodological Considerations.” *Journal of Science and Mathematics Education* 18 (1): 51–66. doi:10.1007/s10763-020-10077-7.

Kazemi, E., L. K. Gibbons, R. Lewis, A. Fox, A. Hintz, M. Kelley-Petersen, A. Adrian Cunard, K. Lomax, A. Lenges, and R. Balf. 2018. “Math Labs: Teachers, Teacher Educators, and School Leaders Learning Together with and from Their Own Students.” *Journal of Mathematics Educational Leadership* 19 (1): 23–36. https://tedd.org/wp-content/uploads/2017/05/JMEL-Math-Labs-2018.pdf.

Kemmis, S., J. Wilkinson, C. Edwards-Groves, I. Hardy, P. Grootenboer, and L. Bristol. 2014. *Changing Practices, Changing Education*. Singapore: Springer.

Lingard, B., D. Hayes, M. Mills, and P. Christie. 2003. *Leading Learning: Making Hope Practical in Schools*. Maidenhead: Open University Press.

Lipscombe, K., S. Tindall-Forde, and P. Grootenboer. 2019. “Middle Leading and Influence in Two Schools.” *Educational Management Administration and Leadership*, 48(6), 1–17. doi:10.1177/1741143219880324.

Martinovic, D., and N. El Kord. 2018. “Content Leadership in Mathematics Education: A Literature Review.” *Mathematics Learning Network*. http://mkn-rcm.ca/wp-content/uploads/2016/11/Teacher-Leadership-Literature-Review-2-2018-11-05.pdf.

Masters, G. 2010. *Teaching and Learning: School Improvement Framework*. State of Queensland (Department of Education and Training) and Australian Council for Educational Research

(ACER). https://research.acer.edu.au/cgi/viewcontent.cgi?article = 1015&context = monitoring_learning.

Moustakas, C. E. 1994. *Phenomenological Research Methods*. London: Sage Publications.

Robinson, V. M. J., C. A. Lloyd, and K. J. Rowe. 2008. "The Impact of Leadership on Student Outcomes: An Analysis of the Differential Effects of Leadership Type." *Educational Administration Quarterly* 44 (5): 635–674. doi:10.1177/0013161X08321509.

Sexton, M. 2019. "Object-Motives of Mathematics Leaders' Professional Learning Leadership During Participation in a Mathematics Project." In *Mathematics Education Research: Impacting Practice*, edited by G. Hine, S. Blackley, and A. Cooke, 660–667. Perth: Mathematics Education Research Group of Australasia. https://merga.net.au/Public/Publications/Annual_Conference_Proceedings/2019-MERGA-conference-proceedings.aspx.

Sexton, M., and A. Downton. 2014. "School Mathematics Leaders' Perceptions of Successes and Challenges of Their Leadership Role within a Mathematics Improvement Project." In *Curriculum in Focus: Research Guided Practice*, edited by J. Anderson, M. Cavanagh, and A. Prescott, 581–588. Mathematics Education Research Group of Australasia.

Sexton, M., and J. Lamb. 2017. "Using Activity Theory to Understand a Mathematics Leader's Motivations and Use of Mathematical Knowledge for Teaching." In *40 Years on: We Are Still Learning!*, edited by In A. Downton, S. Livy, and J. Hall, 466–473. Melbourne: Mathematics Education Research Group of Australasia. https://merga.net.au/Public/Publications/Annual_Conference_Proceedings/2017_MERGA_annual_conference_proceedings.aspx.

Spillane, J. P., R. Halverson, and J. B. Diamond. 2001. "Investigating School Leadership Practice: A Distributed Perspective." *Educational Researcher* 30 (3): 3–28. doi:10.3102/0013189X030003023.

Sullivan, P. 2020. *Leading Improvement in Mathematics Teaching and Learning*. Melbourne: ACER Press.

Vale, C., J. Cheeseman, A. Downton, A. Gervasoni, P. Kalogeropolous, S. Livy, A. Roche, and J. Russo. 2020. *Bastow Numeracy Leaders' Needs Analysis*. Victoria: Bastow Educational Leadership, Department of Education and Training.

Vale, C., A. Davies, M. Weaven, N. Hooley, K. Davidson, and D. Lorton. 2010. "Leadership to Improve Mathematics in Low SES Schools and School Networks." *Mathematics Teacher Education and Development* 12 (2): 47–71. https://mted.merga.net.au/index.php/mted/issue/view/10.

Wilkie, K. J., and H. Tan. 2019. "Exploring Mathematics Teacher Leaders' Attributions and Actions in Influencing Senior Secondary Students' Mathematics Subject Enrolments." *Mathematics Education Research Journal* 31: 441–464. doi:10.1007/s13394-019-00264-3.

York-Barr, J., and K. Duke. 2004. "What Do We Know About Teacher Leadership? Findings from Two Decades of Scholarship." *Review of Educational Research* 74 (3): 255–316. doi:10.3102/00346543074003255