School-Based Coaching: Examining Disciplinary Literacy Learning for Secondary Mathematics Teachers

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BHMS(Ed)

Submitted in fulfilment of the requirements for the degree of
Master of Philosophy

School of Teacher Education and Leadership
Faculty of Creative Industries, Education and Social Justice
Queensland University of Technology
2022

Keywords

case study, coaching, collaboration, communities of practice (CoPs), disciplinary literacy, literacy, mathematical literacy, mathematics, nested case study, pedagogical content knowledge (PCK), professional development (PD), professional learning (PL), secondary mathematics teachers, self-efficacy, social theory of learning

Foreword

The impetus for this research project started when I was working as a full-time literacy coach, with a growing realisation about effective literacy practices across a range of disciplines. I started investigating the complexities of literacy coaching for teachers of mathematics. When school-wide professional development focused on signature reading practices for teachers to employ during reading activities, some mathematics teachers requested further support to apply these practices. Generally, the secondary mathematics teachers who engaged with coaching reported they had not experienced sufficient pre-service or in-service training in disciplinary literacies, that is, the literacies inherent in the discipline of mathematics. I saw firsthand the reluctance of some teachers to explicitly teach reading and processing in mathematics using generic reading, writing, and thinking strategies.

By 2020 my career took a turn towards school administration, as I accepted a deputy principal position in a large, high-performing, metropolitan secondary school. Reservoir State High School (a pseudonym) was focused on implementing their new pedagogical framework and intended to use a coaching approach to develop teacher pedagogies. My leadership portfolio included developing a pilot coaching approach to support ongoing, meaningful, and collaborative professional learning for teachers. For me to conduct disciplinary literacy research while developing a coaching approach meant that some mathematics teachers at Reservoir State High School had an opportunity to expand their professional learning.

As a literacy coach, I predominantly drew from a range of reading, writing, and thinking strategies. While the majority of these would now be considered content-area strategies, I was practised in applying specific graphic organisers or genre-based approaches in subject areas such as science, history, and English. For example, using cause and effect or problem–solution organisers in science and history supported students to summarise key events or show relationships. Character profiles, plot summaries, and paragraph templates supported thinking and processing for students in English. However, in mathematics, the application of generic or content-area strategies as a one-size-fits-all approach was not appropriate. As reported by teachers during coaching conversations, they were still challenged by the literacy of the discipline. My own teaching experience and expertise was in subjects such as Health and Physical

Education, English, and humanities. I had no prior experience with teaching mathematics, and as a learner in the community of practice, attempted to learn more about this discipline.

My desire to conduct research into coaching and disciplinary literacy was sparked by teachers' needs for timely, ongoing professional learning. I embarked on this research project to educate myself more broadly so that I could support secondary teachers across all faculties, and develop an authentic, credible coaching program to tailor learning opportunities and provide meaningful collaborations about practice.

By conducting my research study with secondary mathematics teachers at Reservoir State High School, the focus of my research was based upon school-based coaching, collaboration, pedagogy, and disciplinary literacy learning.

Abstract

This study was derived from the researcher's literacy coaching role in a Queensland secondary school, and the desire to better understand mathematical disciplinary literacies for the purpose of supporting mathematics teachers' professional learning. Coaching is an established collaborative method of professional learning that is growing as a preferred model in educational contexts such as schools. Disciplinary literacies are increasingly recognised as an area of professional learning need for teachers, yet literacy coaching in mathematics has been identified as under-researched.

The aim of this study was to examine early-phase disciplinary literacy learning for secondary mathematics teachers over a 10-week term. Using a qualitative, exploratory case study design, a trial coaching program was based on a communities of practice (CoP) approach. Its central concern was to gain a deeper understanding of the ways in which school-based coaching can foster disciplinary literacy awareness for secondary mathematics teachers.

Study data were collected via researcher coach (RC) reflective journal entries, semi-structured focus groups, and individual semi-structured interviews. The RC anticipated that coaching had the potential to support changes in teachers' pedagogical practices as they developed mathematical disciplinary literacy awareness.

The major findings encompassed both coaching and disciplinary literacy learning areas. Within the coaching domain, the RC learned that teachers liked coaching as a form of professional learning (PL), regarding it as supportive, timely, and relevant. Teachers' identity and self-efficacy within the mathematics discipline were also enhanced. The study results further showed that when teachers incorporated disciplinary literacy strategies, students were more engaged.

The implications of the study's findings positively position coaching as an effective resource for deeper understanding of disciplinary literacies while facilitating a CoP, where reciprocity, collaboration, and trust are key elements. Further, the benefits of disciplinary literacy knowledge and understanding could empower teachers seeking to enhance their pedagogical repertoire to support student outcomes. Directions for future research include exploration of coaching as a preferred method of teacher PL in other disciplines.

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List of Abbreviations

ACARA	Australian Curriculum, Assessment and Reporting Authority
ACER	Australian Council for Educational Research
AITSL	Australian Institute for Teaching and School Leadership
ALEA	Australian Literacy Educators' Association
ATWD	Australian Teacher Workforce Data
COAG	Council of Australian Governments
CoP; CoPs	community of practice; communities of practice
CUBES	circle, underline, box, evaluate/eliminate, solve
DEA	Department of Education and the Arts
DEECD	Department of Education and Early Childhood Development
DET	Department of Education and Training
DETE	Department of Education, Training and Employment
DoE	Department of Education
EAL/D	English as an additional language or dialect
EIB	Education Improvement Branch
EIRC	Education Improvement Research Centre
ELL	English language learner
GRR	gradual release of responsibility
KCS	knowledge of content and students
KCT	knowledge of content and teaching
LPP	legitimate peripheral participation
MAST	Mathematics as Storytelling
NAPLAN	National Assessment Program – Literacy and Numeracy
NCTM	National Council of Teachers of Mathematics
OECD	Organisation for Economic Co-operation and Development
PAT-R	Progressive Assessment Test in Reading
PAT-M	Progressive Assessment Test in Mathematics
PCK	pedagogical content knowledge
PD	professional development
PETAA	Primary English Teaching Association Australia
PISA	Programme for International Student Assessment

PL	professional learning
PLC	professional learning community
QCAA	Queensland Curriculum and Assessment Authority
QERI	Queensland Education Research Inventory
QUT	Queensland University of Technology
RC	researcher coach
SMART	specific, measurable, achievable, realistic, time-bound
STEM	science, technology, engineering, and mathematics

Acknowledgements

I would like to acknowledge the guidance and wisdom of my supervisory team: Dr Deborah Henderson, Associate Professor; Dr Lisa van Leent, Senior Lecturer, and Dr Bronwyn Ewing, Associate Professor in the School of Teacher Education and Leadership, Faculty of Creative Industries, Education and Social Justice at the Queensland University of Technology. Thank you for your dedication and support.

I acknowledge my teacher colleagues, those inspiring people doing the toughest but most rewarding work, and all of you who believed in collaboration with me as your coach.

Thank you to Katrina Cush-Russell for making all the figures at short notice, Jean Bowra for transcribing services, and my school principal for granting permission to conduct research.

Thank you to Charlotte Cottier (Accredited Editor with the Institute of Professional Editors), who provided copyediting and proofreading services according to the guidelines laid out in the university-endorsed national *Guidelines for editing research theses*.

Finally, I would like to thank my husband, Paul Hodgson, for his unwavering support and for keeping me on task during some difficult life events while conducting higher degree research, and my sister, Dr Heather J. Buchanan, for being my champion and sounding board, always by my side.

Chapter 1: Introduction

This research study investigated an early-phase school-based coaching program in one Queensland secondary school, and how it influenced secondary mathematics teachers' experiences of teaching disciplinary literacy learning. Its central concern was to explicate from the teachers' experiences how the trial coaching program influenced their learning about teaching disciplinary literacies. The research project focused on four secondary mathematics teachers' experiences of learning about disciplinary literacy teaching in mathematics classrooms, and the researcher coach (RC) in the same setting. The analysis of participants' experiences and accounts illustrated the ways in which the teachers identified aspects of the coaching program which fostered awareness about teaching disciplinary literacies in mathematics.

This chapter presents the background and context of the study, followed by its purpose, the research questions, the project's significance, and an overview of the theoretical framework, research design and structure of the thesis.

1.1 Background and Context

Driven by international pressure and global competitiveness measured by tests such as the Programme for International Student Assessment, or PISA (Organisation for Economic Co-operation and Development [OECD], 2014), the Queensland Government has committed to improving students' educational outcomes (Department of Education [DoE], 2021b). To improve student outcomes, a suite of school improvement agendas by the Education Improvement Research Centre (EIRC) has focused on teacher expertise (EIRC, 2021b). Coaching has been identified as one strategy for improving the capacity of teachers to make a positive impact on student learning outcomes. Despite a heavy content focus in secondary teacher preparation, governments and many Queensland schools now expect secondary school teachers to explicitly teach the literacies of their subject (Australian Curriculum, Assessment and Reporting Authority [ACARA], 2020; Department of Education and the Arts [DEA], 2006; Department of Education, Training and Employment [DETE], 2011). Literacy learning is considered along a continuum within the Australian Curriculum, and the national learning progressions "describe the skills, understandings and capabilities that

students typically acquire as their proficiency increases in a particular aspect of the curriculum over time" (ACARA, 2020, p. 5). In particular, subject-specific disciplinary literacies have come into focus, with greater pressure for Queensland teachers to improve students' reading, writing, and overall literacy (DoE, 2021b; DETE, 2012).

Secondary school teachers are prepared to teach subject content more rigorously than they are trained to teach literacy and reading (Fang, 2014; Phillips et al., 2009). In Australia, students transition from primary school at around 12 years of age, where both literary and non-literary reading skills are taught using content-area reading and generic literacy strategies across the different subject areas or disciplines. Secondary students, aged 12–18 years of age (in Years 7–12), start to encounter a wider range of disciplines. In the USA, Elish-Piper et al. (2016) state:

> a common frustration for middle and high school[1] teachers is that, when using content-area reading strategies that focus on general comprehension skills such as summarization or prediction, they feel they are spending time "teaching reading" rather than teaching their content. (p. 2)

What has emerged from research into literacy and the broad application of content-area reading across disciplines in secondary school is the recognition of the unique ways of working within each subject. Goldman et al. (2016) conducted literacy research to identify discipline-specific, core constructs, including epistemology; inquiry practices/strategies of reasoning; overarching concepts, themes, and frameworks; forms of information representation/types of texts; and discourse and language structures (p. 2). Acknowledgment of "differences across disciplinary areas of study in the nature of reading and reasoning processes" (Goldman et al., 2016, p. 3) has produced the term *disciplinary literacy* (Di Domenico, 2014; Elish-Piper, 2018; Fang & Coatam, 2013; Fang & Schleppegrell, 2010; T. Shanahan & Shanahan, 2008).

The literature states that teaching the discipline of mathematics in a secondary school can be challenging (Adams, 2003; del Prado Hill et al., 2016; Doerr & Temple, 2016). Secondary level mathematics requires what Goldman (2012) refers to as "disciplinary content instruction" (p. 89), that is, an approach which allows students to meet the precise reading, thinking, writing, and processing requirements of a subject

[1] In the USA, middle school students are aged 11–13 years and high school students 14–18 years.

which uses symbols, numbers, and words. An in-depth critique of the literature that highlights the literacy demands in secondary mathematics is provided in Chapter 2.

Coaches are becoming a familiar sight in some school settings to support teacher capability, as the focus on improved educational outcomes, particularly for literacy and numeracy skills, drives professional learning. An example of this focus is found in the content of some Australian federal and state government reports; the first item in the list of improvement objectives is often "literacy and numeracy", along with topics such as early childhood, senior pathways, and general capabilities, such as critical and creative thinking (ACARA, 2021a; DEA, 2006; DETE, 2012; DETE, 2013b).

In Queensland, a recently published spotlight paper from the DoE's Education Improvement Branch (EIRC, 2021b) identifies classroom coaching as a set of collaborative professional learning activities which focus on instruction in the classroom context using observation and feedback for reflection and learning. Insights and spotlight papers are a direct result of the state government's systematic school review processes – periodic reviews of schools conducted by expert teams which then make recommendations and share findings across the state. There has been a rise in discussion papers and strategic documents from state and federal government bodies, recommending coaching or collaborative professional learning approaches for school leaders and teachers (Australian Institute for Teaching and School Leadership [AITSL], 2013; DoE, 2020; EIRC, 2021a, 2021b).

In educational settings, the range of coaching types is diverse. These include, but are not limited to, instructional coaches, literacy and/or numeracy coaches, and disciplinary literacy coaches (Bengo, 2016; Elish-Piper, 2018; Knight, 2009, 2010; Lilly, 2012; Loeschen, 2012; Sailor & Shanklin, 2010). In Australia, Canada, and the USA, coaches are found in a range of contexts from primary/elementary (students aged 5–11 years), to middle and senior (secondary) schools (students aged approximately 12–18 years). Fullan and Knight (2011) argue that coaches in schools are system leaders and agents of strategic change, and as such, their role must be carefully managed to align with improvement agendas. For effectiveness, Fullan and Knight assert that districts and regions should coordinate and share change processes such as coaching, to build teacher capacity more broadly.

Mirroring the increase of coaching in schools is the rise of support for teacher collaboration (Brouwer et al., 2012; Gill et al., 2010; Manouchehri, 2001).

Collaboration focuses on active approaches to learning for teachers, for example, teamwork and peer support, with the sharing of feedback and ideas either in person or in an online community (Gellert, 2013; Goos & Bennison, 2008; Manouchehri, 2001; Reasoner, 2017). Some schools provide teachers with opportunities to collaborate with colleagues in teacher teams on a range of teaching and learning activities, with the belief that sharing curriculum and pedagogy knowledge builds capacity (Brouwer et al., 2012; T. Cox, 2011). Indeed, Timperley (2015) contends that "professional conversations and improvement-focused feedback among teachers are essential for developing great leadership, teaching and student learning" (p. 4). With a push towards collaborative professional learning, building a collaborative learning culture, and planning school-wide professional learning opportunities to support teacher capability, this project was timely and targeted towards a particular group of secondary teachers, those who teach mathematics.

1.2 Purpose of the Study

The purpose of the study was to explore a coaching approach to support disciplinary literacy learning for secondary mathematics teachers. The main research question for the study was: *How can an early-phase coaching program influence secondary mathematics teachers' disciplinary literacy learning?* The following sub-questions guided the research:

1. *What disciplinary literacies do secondary mathematics teachers draw on when teaching mathematics?*
2. *How can an early-phase coaching program work to strengthen secondary mathematics teachers' disciplinary literacy learning?*
3. *How does an early-phase coaching program contribute to mathematics teachers' disciplinary literacy learning?*

1.3 Significance and Definitions

There are several reasons for the project's significance. The first reason is the project's focus on literacy coaching in mathematics, which has been identified as under-researched in the empirical literature. What is known is that more traditional approaches have focused on either improving mathematics instruction through numeracy coaching, or using pedagogical solutions (del Prado Hill et al., 2016; Kane,

2013; Walters, 2014). The second reason is the project's focus on mathematics in a secondary school. With the current international and national emphasis on science, technology, engineering, and mathematics (STEM) related careers, secondary school students have been strongly encouraged to consider STEM as a potential future career pathway (Department of Education and Training [DET], 2016). At the time of writing, an identified teacher shortage has added to the urgency of securing qualified teachers, particularly in the disciplines of mathematics and science (Australian Teacher Workforce Data [ATWD], 2021). The third reason for the project's significance is its focus on coaching with secondary mathematics teachers. International and national literature has identified a general acceptance of coaching in schools; however, little is known about mathematics teachers and their perceptions of their learning through a coaching program focused on literacy (Ferguson, 2014; Gill et al., 2010; Sharplin et al., 2016).

There are two key components that need to be understood relationally and in terms of their contribution to this study: coaching and disciplinary literacy. Each will now be briefly discussed.

Coaching as a concept has developed from the business world (Knight, 2009) and evolved into a form of situated, ongoing professional development. Broadly speaking, coaching in this project refers to the presence of an experienced professional peer who is able to listen, ask questions, clarify and summarise ideas, and collaborate with participants to facilitate professional learning (Burkins, 2009; Knight, 2009; van Nieuwerburgh, 2017).

Disciplinary literacy is defined by McConachie and Petrosky (2010) as "the use of reading, reasoning, investigating, speaking, and writing required to learn and form complex content knowledge appropriate to a particular discipline" (p. 16). Acknowledging the specific receptive and productive skills which underpin each subject or discipline is central to the learning process of secondary teachers and the RC in this study. Throughout Chapter 2 and Chapter 3, various other key terms and concepts will be introduced and explained.

1.4 Theoretical Framework

This study explored secondary mathematics teachers' disciplinary literacy learning experiences in an early-phase coaching program through a community of practice (CoP) approach (Lave & Wenger, 1991; Wenger, 1998), underpinned by the social theory of learning (Lave & Wenger, 1991; Wenger, 1998). This framework provided a lens through which insights were gained into teachers' learning through social participation in a collaborative coaching program. Central to this approach is Wenger's (1998) four premises about learning: that humans are social beings, that knowledge is measured and valued differently in various contexts, that learning and knowing can result from actively participating in valued enterprises, and that experience and engagement in the pursuit of learning provides meaning. Chapter 3 describes in more detail this theoretical framework, its key components, and the way communities of practice (CoPs) interact.

1.5 Research Design

A qualitative, exploratory case study design was adopted in this study as it provided the potential to gain an in-depth description and analysis of the experiences of mathematics teachers involved in the early phase of a coaching program with a focus on disciplinary literacy at one school site. Simons (2009, p. 21) notes that a case study design enables the researcher to study the "complexity and uniqueness" of a program or system in "real life". As this is an exploratory research project (Neuman, 2003), a range of qualitative instruments provided rich data for analysis. Four mathematics teachers participated in this exploratory case study (Thomas, 2011; Yin, 2009, 2012) by engaging in an early-phase collaborative process with the RC over a 10-week period. The process involved teachers setting professional learning goals focused on disciplinary literacies in mathematics. Throughout the coaching program, data were collected via two semi-structured focus groups, two individual semi-structured interviews, observations, reflections, and field notes in the RC's reflective journal. Through thematic analysis (Braun & Clarke, 2006), the data revealed the outcomes related to teachers' efficacy in teaching mathematical literacies and their perspective on the impact of coaching on disciplinary literacy learning.

1.6 Thesis Outline

The structure of this thesis is as follows. Chapter 1 has outlined the background and context, provided the purpose and research questions of the study and its significance within the field of disciplinary literacy in secondary education, and described the theoretical framework and research design of the project.

Chapter 2 presents the literature review, which discusses seven topics related to the study. Section 2.1 addresses teacher professional learning, and Section 2.2 addresses the rise of coaching as a method of professional learning in Australian schools. Section 2.3 explores self-efficacy and its influence on teacher confidence, and Section 2.4 examines the influence of collective efficacy in collaborative groups. Section 2.5 examines the notion of literacy, then Section 2.6 specifically focuses on disciplinary literacy and mathematics. Section 2.7 addresses pedagogical considerations pertinent to this study.

The gap in the literature is the focus on disciplinary literacy coaching in secondary mathematics. While a range of literature examines coaching, literacy, mathematics, and collaboration, there is a gap in empirical research which focuses on the experiences of secondary mathematics teachers participating in a coaching program to support learning about teaching literacy in the discipline.

Chapter 3 outlines the theoretical framework which underpins this research project. A social theory of learning (Lave & Wenger, 1991; Wenger, 1998), where learners interact, participate, and create new knowledge, provides the overarching structure for a CoP approach (Lave & Wenger, 1991; Wenger, 1998).

Chapter 4 describes the study's qualitative research design and methods of data collection and analysis. The work of Yin (2009, 2012) and Thomas (2011) informs the exploratory case study approach. Yin (2009) posits a systematic emphasis on rigorous data collection and careful and articulated data analysis for case studies. In this study, the research instruments included two semi-structured focus groups, two semi-structured individual interviews per participant, and reflections from the RC's reflective journal. For each participant, the RC observed a cycle of lessons and used analysis of reflective notes as data, rather than direct observation material. Coding of data was conducted using thematic analysis (Braun & Clarke, 2006). The exploratory case study design provided opportunities to gain an understanding of how a coaching

program in an educational setting influenced secondary mathematics teachers' disciplinary literacy learning.

Chapters 5, 6, and 7 present the findings and discussion, and address research sub-questions one, two, and three, respectively. Three themes gleaned from the data are discussed through the theoretical framework of a social theory of learning and CoPs from Chapter 3 and informed by the research literature from Chapter 2.

Chapter 8 is the concluding chapter, which brings together findings from the data to answer how a coaching program contributes to mathematics teachers' disciplinary literacy learning. Limitations to the study are considered, along with recommendations and directions for further research.

Chapter 2: Literature Review

Chapter 1 presented the central purpose of the study, that is, to explore how coaching can influence secondary mathematics teachers' disciplinary literacy learning. It proposed that there is a growing demand for secondary school teachers to explicitly teach and model disciplinary literacy in each subject area. Drawing on the relevant research literature, this chapter addresses the notion of how a school-based early-phase coaching program could influence secondary mathematics teachers' literacy learning. It critically examines the assumptions and practices of coaching, disciplinary literacy, and efficacy. These topics are described, reviewed, and compared to provide context and deeper understanding of the pedagogical demands of secondary mathematics teachers and school-based coaches. The chapter concludes by identifying a major gap in the research literature that this study seeks to address.

Chapter 2 is structured in seven sections. Section 2.1 discusses teacher professional learning. Section 2.2 focuses on coaching and its rise in recent years as a collaborative form of teacher professional learning in education. Section 2.3 deals with the notion of self-efficacy and the importance of a positive perception of self for teachers working collaboratively. In Section 2.4, the notion of collective efficacy is discussed. Section 2.5 explores the topic of literacy, then more specifically in Section 2.6, the notion of disciplinary literacy and the complexity of literacy in mathematics. Within Section 2.7, pedagogy is discussed with particular reference to pedagogical content knowledge, teacher knowledge of subject matter and the most appropriate way to teach it (Shulman, 1986), and other pertinent pedagogies.

2.1 Professional Learning for Teachers

Ongoing professional learning is a common expectation for educators, and while the push for continuous school improvement is espoused by governments (DETE, 2011; McElearney et al., 2019), the emphasis on teacher professional learning remains. A common assumption is that teachers acquire specialist knowledge and skills as they teach. New initiatives and changes within the education system signal new ways of working. The terms *professional development* (PD) and *professional learning* (PL) could seem interchangeable; however, for the purposes of this study, PL, which has

interaction at its core, is the preferred term. PD has traditionally been represented by lecture-style workshops or one-off sessions. Knight (2009) refers to these sessions as "one-shot programs" (p. 3) and notes low implementation rates, potentially frustrating both teachers and leaders. PD literature has informed the research base for this study, and while at times I use both terms, I consider the coaching program as PL. When analysing literature, I use the term PD or PL, whichever is used by the authors.

Clarke (1994) synthesised key PD literature and outlined 10 key principles to guide planning of PD for teachers. These principles are as follows: (a) address issues of concern and interest as identified by teachers, and involve a degree of choice for participants; (b) involve groups of teachers rather than individuals and enlist support of the administration and broader community; (c) recognise and address the many impediments to teachers' growth at the individual, school, and district level; (d) use teachers as participants in real situations and model desired approaches during in-service sessions; (e) solicit teachers' commitment to participate actively in PD sessions, undertake required readings, and adapt strategies for use in their own classroom; (f) recognise that change in teachers' beliefs about teaching and learning are derived largely from classroom practice, thus changes in student learning may validate professional learning; (g) allow time and opportunities for planning, reflection, and feedback, to share the "wisdom of practice" with the group, and to discuss problems and solutions regarding students and teaching approaches; (h) enable participating teachers to gain ownership by their involvement in decision-making and by being regarded as true partners in the change process; (i) recognise that change is a gradual, difficult, and often painful process, requiring ongoing support from peers and critical friends; and (j) encourage participants to set further goals for their professional growth (Clarke, 1994, p. 38). My study, which implemented a coaching approach, focused particularly on principles (b), (f), (g), and (i). Interestingly, Clarke's research noted that despite being the most commonly held type of PD, the least useful style was the one-off or single-session workshop.

Since Clarke's (1994) work was published, other researchers have identified teachers' needs as a priority for PL; however, understanding what teachers need is not straightforward. Beswick (2014) investigated three different PL approaches for mathematics teachers, noting the importance of focusing on their identified needs, as well as those experiences which provide opportunities for teachers to change their

beliefs. Teachers' beliefs underpin their perceptions of themselves as educators; therefore, some PL may be confronting or difficult if it is not appropriately structured. The risk of appearing vulnerable was suggested as a reason why some teachers found it difficult to articulate their PL requirements. Beswick's (2014) study noted the challenge in asking teachers about their PL needs, particularly when teachers need to feel valued and respected, and trust in the process of learning. Franke et al. (2001) conducted research into sustainable change in teaching practice as a result of PL to better understand students' mathematical thinking. One key finding was that teachers who focused on interacting, listening, and learning from students were able to inform and further structure their classroom practices to support students' mathematical thinking. A common theme among these participants was the support of colleagues engaged in the program, and the researchers noted that up to 4 years later, teachers maintained some focus on children's mathematical thinking (Franke et al., 2001).

Teacher identity can change as individuals become more experienced, and is a key aspect for consideration when introducing PL programs. Clemans et al. (2010) conducted research with both primary and secondary teachers; their insights about teacher identity resonate with the role of a coach, which Clemans et al. refer to as a teacher educator. A coach is often an experienced colleague who has a range of curriculum and pedagogical knowledge, as well as relational skills to develop trusted relationships (Boyd, 2008; Fullan & Knight, 2011). Clemans et al. note that teacher educators, that is, teachers who have transitioned from full-time teaching to roles such as coaching and educating others, may face challenges with their identity. This could be related to a change in their perceived identity as "a teacher" and as "an educator", and the ways people who feel vulnerable about change try to protect their identity. This is relevant to the current study, because by understanding more about the early-phase coaching program and the role of teacher educators, more is revealed about sustainable, collaborative PL approaches in schools.

The next section focuses on the rise of coaching in schools as a sustainable response to foster collaboration and basis for building trust to support teacher PL.

2.2 Coaching in Schools

Coaching has become an increasingly significant form of teacher PL internationally and in Australia (Department of Education and Early Childhood

Development [DEECD], 2010; Fullan & Knight, 2011; Manouchehri, 2001; B. Tschannen-Moran & Tschannen-Moran, 2011; van Leent & Exley, 2013). Showers and Joyce (1996), pioneers of educational research into teaching practice, explored effective teacher development as early as 1980. Frustrated with low transference rates of teaching strategies from one-off PD sessions, the researchers hypothesised that regular, ongoing PL would support practice and implementation more effectively. The aim of coaching is to build trusted, sustainable, collaborative relationships between teachers and a coach, which develop and extend professional teaching practice to benefit students' learning.

The presence of coaches in educational settings has developed since the late 20th century and, in Australia, is supported by organisations such as AITSL. The state of Victoria developed a coaching approach through the systematic implementation of coaches (Boyd, 2008), and as a result of research into coaching in government schools, the Victorian Government developed *Coaching Initiatives*, a strategy to provide school-based PL to teachers. Outcomes of this project included improved student literacy and numeracy outcomes and ongoing whole-school reform, such as better curriculum alignment and a collaborative, respected team ethos (DEECD, 2014).

As previously noted, frustration with traditional one-off PL models for teachers have informed the development of coaching in schools. Kraft and Blazar's (2013, 2017) research noted ongoing benefits for teachers and students from coaching models of PL, when compared with traditional PD. The researchers observed that coaching was more likely to adapt to individuals' needs, whereas other PD models were generalised and often brief. Coaching was determined as more effective than standard PD, with some evidence that improvements in teacher practice were noted in the following academic year, when participants were no longer engaged with coaching (Kraft & Blazar, 2013, 2017).

Joyce and Showers (2002) identify four components of teacher training required to support the transfer of effective practice into the classroom: "theory + demonstration + practice + feedback" (p. 2). This routine is considered pedagogically sound today, albeit in a more contextually complex, data-driven educational climate (Boyd, 2008; Hopkins, 2011). The Queensland DoE's spotlight paper (EIRC, 2021b) reinforces Joyce and Showers' early work, with their version of effective teacher training

comprising study of theory, demonstration and observation, practice, feedback, and classroom application and coaching (p. 4).

Throughout Queensland, it is not clear how coaching occurs across education sectors. The Queensland DoE supports coaching as a method of teacher and leader PL via the Autism Hub and Reading Centre facility. Educators have access to four reading coaches, who deliver PD to teachers from government and non-government schools (Autism Hub and Reading Centre, 2018). Temporary coaching role position statements appear in DoE recruitment advertisements, for example, early years coach, pedagogy coach, and literacy and/or numeracy coach (DoE, 2022c). Individual schools and principals still have an opportunity to create temporary positions and appoint coaches using government grants (DoE, 2022b); however, permanent coach roles are not classified roles in the DoE (DETE, 2013a).

Since the start of the RC's research journey, the DoE's Education Improvement Branch (EIB) have gradually begun to focus attention on coaching for embedded, ongoing, and sustainable PL. Coaching and the presence of coaches in Queensland schools now seem more prominent in government-funded publications than in 2017. In 2021, authors from the EIRC produced two papers outlining key findings from the EIB's systematic school review process, and two themes resonate with the current study – collaboration and coaching. *Learning together to build teaching mastery* (EIRC, 2021a) reinforces collegial engagement and collaboration to support teacher expertise. The opening statement sends a strong message to teachers and leaders: "Professional learning is most effective and has greater impact on teaching expertise and student learning when it is collaborative" (EIRC, 2021a, p. 1). This paper advocates for instructional leadership skills for school leaders, as well as classroom coaching and mentoring programs to lead change and improvement agendas. *Classroom coaching that makes a difference* (EIRC, 2021b) continues with the collaborative learning focus; however, it focuses more explicitly on school-based classroom coaching programs to support teacher PL. The second paper summarises data on coaching and mentoring practices across Queensland schools and notes that "classroom coaching is the most common theme in school review recommendations about building staff capability" (EIRC, 2021b, p. 2).

Campbell and van Nieuwerburgh (2018) delineate between the notions of coaching and a coaching approach. They describe coaching as a one-to-one

conversation between a coach and coachee, and define a coaching approach as "intentionally utilizing some of the transferable elements of formal coaching in a range of conversational situations that would not typically be considered coaching interactions" (p. 18). Campbell and van Nieuwerburgh propose that schools use a coaching approach in many different conversations, including team discussions, performance reviews, or even in hierarchical structures such as line management. Aspects of a coaching approach include a focus on learning, awareness of self and others, personal responsibility, support and challenge, and being non-evaluative (Campbell & van Nieuwerburgh, 2018). When building a coaching program in any school, consideration of a coaching approach may support a school's improvement agenda more broadly, while supporting a range of programs.

An assumption underpinning the coaching agenda both in Australia and overseas, and influenced by the research of Hattie (2003), is the belief in the power of effective teachers and their influence on student achievement. The assumption is that building teacher capacity through supportive collaboration enables effective teachers to positively affect student outcomes (Bengo, 2016; Fisher et al., 2016). Participating in and valuing coaching as an educational change agenda is crucial to sustainable changes in both teacher practices and student outcomes (Fullan & Knight, 2011; Knight, 2009, 2010).

It could be argued that building a school culture which supports professional growth for teachers requires a successful coaching program that is informed and supported by consistent leadership. Devine et al. (2013) conducted a systematic review of coaching in education based on three aspects: students, teachers, and school leaders. The key finding from their research noted, "ultimately school improvement will fail if coaching remains on an individual level. Therefore, systems of collective and collaborative learning are necessary to generate a collective learning culture" (p. 1382). The DoE's *Leadership Strategy 2020–2022* clearly outlines expectations for school leaders, who should "provide coaching, mentoring and collegiate support programs", which include building "the coaching capability of leaders to provide collegiate and employee support" (DoE, 2020, p. 6).

An empirical analysis of instructional leadership, teacher collaboration, and collective efficacy to support student learning was conducted by Goddard et al. (2015). The researchers investigated school reform programs by focusing on links between

"school leadership to collective efficacy, through teacher collaboration" (p. 503). While other studies have looked closely at teacher efficacy and student outcomes, Goddard et al. posit a positive link between principal leadership and improved student outcomes. The following excerpt from this study reinforces the notion of strong and informed leadership support to enable teachers to build capability: "Studies of the influence of school leadership on achievement often fail to analyse what teachers do to become more effective because of strong leadership" (p. 503). These findings resonate with me in my leadership role, which includes a coaching development portfolio at Reservoir State High School.

Internationally and nationally, coaching is purported to effect change in educational settings. Reports of its effectiveness have identified coaches as leaders of change, with a significant level of influence among school districts (DEECD, 2014; Fullan & Knight, 2011; Lilly, 2012). With informed and effective leadership support, coaches can lead change by supporting teachers to reflect on their current classroom practices and set improvement goals to positively influence student outcomes.

2.2.1 Coaching Types

Research into coaching in education reveals a variety of coaching and coach types. The following summary lists some common coach types in educational settings.

- Instructional coach: An on-site coach who "work[s] with teachers to incorporate research-based instructional practices" (Knight, 2009, 2010). For example, they may introduce high-yield reading strategies like the Three Level Guide (Herber, 1978).
- Literacy coach: A broad term which covers coaches with a range of responsibilities related to supporting teachers to improve students' reading and/or writing (Ferguson, 2014; Ippolito, 2010; Knight, 2009, 2010; Sailor & Shanklin, 2010).
- Disciplinary literacy coach: A specialised form of literacy coach who works with teachers in different subjects (disciplines) as a collaborator, to apprentice students into the ways of thinking, reading, writing, and speaking unique to each discipline (Elish-Piper et al., 2016).
- Peer coach: A teacher colleague who supports and observes lessons and shares feedback about observations (Showers & Joyce, 1996).

- Cognitive coach: A coach who focuses on changing people's thinking and beliefs in order to change behaviours (Eger, 2006; Knight, 2009; Loeschen, 2012).
- Mathematics/numeracy coach: A coach with a similar function to the literacy coach but with a focus on numeracy (Bengo, 2016; Polly et al., 2013; Widjaja et al., 2015).

In this study, disciplinary literacy coaching and instructional coaching are central. Furthermore, both types align with the methodology of the proposed study, as outlined in Chapter 4. A discussion of each one is now provided.

Disciplinary literacy coaching has emerged from the general domain of literacy coaching. This type of coach is more likely to exist in a secondary school context.[2] Di Domenico et al. (2017) state that "in a high school environment, coaches must also be willing to immerse themselves into the disciplines because they need to understand the discipline-specific goals so they can target their coaching to address each teacher's needs" (p. 4). Students in Australian secondary schools, particularly in the senior secondary grades (aged 15–18 years) begin to specialise, selecting subjects most often taught by content experts, and more discipline-specific expertise is required (Fang, 2014). Research into disciplinary literacy coaching emphasises the RC's ability to "be an expert collaborator and learner who positions the teacher as the expert" (Elish-Piper et al., 2016, p. 12). This approach to coaching is relevant to this study due to the focus on secondary mathematics teachers' deeper content knowledge, and the RC's literacy coaching experience.

Instructional coaching (Knight, 2009, 2010) is underpinned by a partnership approach, which is guided by seven important principles: equality, choice, voice, dialogue, reflection, praxis, and reciprocity. Bengo (2016) explains that instructional coaches must work closely with teachers, listening and responding to individual needs – the instructional coach must consider "behaviour, content, instruction, and formative assessment" (p. 89). Bengo determined that different coaching models and approaches have merit, as effective coaches are "able to determine the teacher's needs" (p. 88). Some schools determine their coaching requirements based upon the context of each setting (Knight, 2009; Showers & Joyce, 1996), considering site-specific student

[2] Australian secondary schools: Years 7–12; American high schools: Years 9–12.

learning needs, as well as human, physical, and financial resources. This type of approach is useful in the design of the early-phase coaching program because a partnership between the teachers and coach, supported by choice, voice, and reflective practices, provides a reciprocal learning opportunity.

The methodology for this study is detailed fully in Chapter 4; however, it aligns with disciplinary literacy coaching and instructional coaching types in the following ways. It supports teachers in consultation with a coach to set goals related to student learning gaps, decide on instructional strategies and pedagogical approaches, and then implement them while being observed in a cycle of observation and reflective discussion.

Coaching in schools is as diverse as the coach types, from state-wide approaches in Victoria (Gill et al., 2010; Timperley, 2011) to district-wide, shared coaching initiatives which support consistent teaching practices between schools (Ferguson, 2014). Individual schools may react to poor student performance data by providing a literacy or numeracy coach (Bengo, 2016; Mraz et al., 2008; Polly et al., 2013). A synthesis of coaching literature reveals the most suitable coach as one that meets the needs of teachers and students in each educational setting.

Despite the relative complexity of different schools and different educational systems, the literature reveals some of the commonalities of successful coaching programs. Boyd (2008) has identified key elements, including a focus on improving student outcomes and approaches that are research-based and embedded in teacher practice. Other common factors identified by Boyd (2008) include collaborative and reflective approaches and the importance of supporting coaching programs within a school's culture. As an extension of the notion that school culture is important, Fullan and Knight (2011) purport that there needs to be close alignment between the coach, the teachers' values, and the school/district's explicit improvement agenda. Due to the collaborative and diverse nature of coaching programs, sharing coaches within a district or cluster (Ferguson, 2014) may support small schools to improve student outcomes while building professional teacher networks beyond the campus gates.

2.2.2 Coaching: Trusted Relationships and Collaboration

Trusted relationships in coaching programs are critical (Boyd, 2008; Ferguson, 2014). Markovic et al. (2014) posit that trust as a concept is difficult to define and

quantify; however, the notion that people are more willing to stretch themselves and engage in self-reflective practices if they have trust reinforces its importance. Markovic et al. (2014) emphasise the importance of emotions in understanding trust, as individuals engaging in PL may understand cognitively that a program or process is seemingly valuable, but without trust in the people delivering the program, positive outcomes may not occur.

Coaches are generally experienced practitioners with strong relational skills, as well as subject area and pedagogical knowledge (Boyd, 2008; Fullan & Knight, 2011; Gill et al., 2010; B. Tschannen-Moran & Tschannen-Moran, 2011). A report from Hanover Research (2015) further contends that this role requires expertise, collaboration, differentiation, insight into adult learning, and authentic relationships. The literature suggests that change agendas like coaching may struggle to yield desired improvements without authentic, trusted relationships (Boyd, 2008; Knight, 2009, 2010). E. Cox (2015) posits that coaches use adult learning principles to prompt shifts in teachers' thinking, as teachers must remain in control and direct their own learning. Knowles (1978) differentiates between pedagogy (the art and science of leading children) and andragogy, which is the art and science of leading adults. Adult learners require certain elements when engaging with PL: they need to know why they are learning a topic and whether it has immediate relevance to their work; they respond if learning is problem-centred and if they have been involved in the planning, implementation, and evaluation of their learning. Adults respond to internal motivation, and to experiences which change their beliefs (Knowles, 1978; Knowles et al., 2005).

While much of the research highlights the effectiveness of coaching, there are some caveats to ensure programs are efficiently designed. Boyd (2011) warns that coaching is expensive and can succumb to program failure. Unless a teacher is reflective, willing to change practices, the coaching is considered a core component of the teacher's workload (not additional), and the coaching culture of the school is supportive, a coaching relationship may not lead to student improvement. As previously noted, some research warns against using coaches purely as a one-on-one model (Fullan & Knight, 2011), as there is more to gain from creating a culture of leadership and collective teacher capacity than expecting practices to change from coaches working in individual classrooms. Elish-Piper et al. (2016) describe a variety of disciplinary literacy coaching approaches, which they classify into four models:

teacher-initiated, co-teaching, department/team, and a liaison model (p. 25). Providing teachers with coaching choices supports social learning opportunities, which can benefit teachers and students.

Fullan and Knight's (2011) assertion that "next to the principal, coaches are the most crucial change agent in a school" (p. 50) is based on wide research conducted in school districts across Canada and the USA. They assert successful programs focus on "capacity building, teamwork, pedagogy and systemic reform" (Fullan & Knight, 2011, p. 50), in contrast to systems where poorly articulated development goals, unspecified duties (including clerical work), and predominantly one-on-one teacher coaching are the norm. Fullan and Knight's (2011) findings align with the previously mentioned work of Devine et al. (2013) and their research into coaching in education, where more successful coaching programs involved systems of teachers, leaders, and students and not individual teachers.

Kise (2009) suggests that many teachers may try to avoid collaboration, as previous efforts to work in teacher teams or across faculties may not have yielded the expected positive student outcomes. Kise identifies three levels of collaboration commonly found in schools: level I, superficial; level II, segmented; and level III, instructional. Levels I and II may be the reason some teachers avoid collaborative work; as the names suggest, superficial and segmented efforts may not be viewed positively if time and effort is wasted in unproductive work. If there is a perception that their hard work and effort is not reciprocated, Kise (2009) posits teachers may resist sharing resources, ideas, and information. Practices like collaboration, which may potentially require extra cognitive effort, may not be viewed positively; in some cases, change agendas bring the perception of extra workload. The notion of level III or deep, instructional collaboration (Kise 2009) requires strategic planning, time within the daily work schedule, trust and willingness to share, and measurable goals for determining effectiveness. The presence of a coach to support reflection, and a common framework for discussing teaching and learning, could enable teachers to be more open and sharing of their ideas, beliefs, and learning.

A summary of the coaching literature provides a framework for the development of a coaching program as the basis of this study. B. Tschannen-Moran and Tschannen-Moran (2011) contend that good programs focus on adult learning principles, that is, teacher-centred, no fault, and strengths-based. It is clear that an effective program has

the potential to support secondary teachers to identify their class data profile, make valid interpretations, plan lessons and units according to students' needs, implement precise pedagogy, incorporate targeted literacy strategies, and enable effective professional conversations (Lilly, 2012; Matters, 2006; Timperley, 2011, 2015). The literature reveals successful coaching hinges on more than a coach with content knowledge and good social skills and emphasises that there must also be a shared responsibility (with teachers) for student outcomes, and a culture of collaboration. Further, the literature suggests that a robust coaching program must contain the element of teacher choice, while also fulfilling the needs of students and school authorities.

2.2.3 Coaching to Support Systemic Demands on Teachers

The presence of coaches in education may be interpreted as a response by governments and school administrators to address student performance outcomes. In Australia, students are routinely assessed using standardised tests such as the National Assessment Program – Literacy and Numeracy (NAPLAN), norm-based assessments like the Progressive Assessment Tests (known as PAT) by the Australian Council for Educational Research (ACER), and school-based assessments of literacy and numeracy. In many schools, teachers and coaches are expected to conduct data cycles of inquiry into, for example, reading results, and then enact specific strategies to reach learning goals for all students (Matters, 2006; Renshaw et al., 2013; Timperley, 2011; van Leent & Exley, 2013). For example, measures of reading age can be the metric for assessing reading improvement. In Queensland schools, the *P–12 Curriculum, assessment and reporting framework* states that a criterion-based, five-point assessment scale rates the quality of student achievement from A to E for students in Years 3–10 (DoE, 2022a). To triangulate information, norm-based data and A–E data can then be used in conjunction with work samples or other diagnostic information to influence teaching and learning and the direction of the coaching role (Matters, 2006; Renshaw et al., 2013; Timperley, 2011).

Continuing with the reading data example, to supplement information from the 2-year interval of NAPLAN testing, many schools use other standardised assessments to track literacy and numeracy data over the shorter term. ACER tests for reading comprehension (PAT-R) and mathematics (PAT-M) are now commonly used assessments in Australian schools (ACER, 2022). This information provides teachers,

coaches, and school leaders with a tool for monitoring and tracking yearly growth, as the testing protocol is statistically normed and diagnostic in nature (ACER, 2022).

2.2.4 Coaching to Support Teachers' Data Literacy

While evidence-based practices and student testing remains in the forefront of practice, teachers' data literacy is an ongoing topic for PL (Matters, 2006; Renshaw et al., 2013). In many education systems, the presence of a coach and their job description is likely to be influenced by social and political policy and state-wide agendas, informed by student outcomes. In Australia, the aforementioned national testing scheme (NAPLAN) and national teacher standards, known as the Australian Professional Standards for Teachers (AITSL, 2017), are influential. It can be argued that coaches and teachers can work together to identify suitable student data to support the improvement of learning.

In order to identify effective data practices used by classroom teachers in Queensland schools, Renshaw et al. (2013) investigated teacher practices associated with Standard 5 of the teacher standards (AITSL, 2017), namely the ability of teachers to "assess, provide feedback and report on student learning" (p. 16). Renshaw et al. (2013) reviewed literature related to assessment, data collection and analysis, and interpretation of data used by teachers across government, Catholic, and independent school sectors. Four prominent themes about the focus on data emerged: data and accountability, data and assessment literacy, data and numerate teachers, and finally, using data (Renshaw et al., 2013). One of the eight key findings of this report is titled "the preoccupation with literacy and numeracy data" (p. 12), a hint that perhaps schools are focusing too heavily on diagnostic testing instead of student performance and capability across the curriculum (Renshaw et al., 2013). One of the report's recommendations for principals and school leaders directly identifies "strategically allocating resources" (Renshaw et al., 2013, p. 15) and uses the example of redeploying staff to coach teachers. In light of this, coaching programs have the potential to provide supportive and collaborative environments for teachers to engage in meaningful PL about student data (Ferguson, 2014; Gill et al., 2010).

2.2.5 Coaching and Funding

Current funding to Queensland state schools may provide an opportunity for principals to fund coaching solutions to address their school's teaching and learning needs. Investing for Success is a current Queensland Government initiative (2015–2022) which provides funding for the purpose of improving student learning outcomes across all state schools (DoE, 2022b). As an accountability measure, literacy and numeracy data are measured via standardised testing regimes such as NAPLAN, along with student academic results. Financial support is directly linked to numbers of students enrolled, their academic results, school characteristics including geographical location, and the school's Index of Relative Socio-Economic Disadvantage (DoE, 2021a). As the classroom teacher is an important influence on student academic performance (Hattie, 2003), the presence of a coaching program to support teacher PL may be implemented by school leaders as a way to allocate funding.

This study is focused on coaching to influence the PL of teachers and is not focused on tracking student outcomes. By developing a collaborative PL culture such as coaching, where teachers engage and share their experiences in the process of improving student outcomes, potential benefits to all are immeasurable.

2.3 Self-Efficacy

The previous section on coaching has noted the potential importance of collaborative PL relationships between leaders, coaches, and teachers. This section examines the notion of self-efficacy and makes a connection between the way teachers perceive their identity as practitioners, their learning, and their willingness to improve their practices via coaching.

Bandura (1977a, 1982, 2000, 2001) states that from birth to old age, self-efficacy evolves and serves to regulate an individual's actions and responses to particular tasks. An individual with positive self-efficacy perseveres and rises to a challenge, and is more likely to cope with a changing environment than a person who reacts negatively to a new agenda or expectation. Poor self-efficacy is the result of previous unsuccessful experiences (Bandura, 1977a). When combined with obstacles such as negative perceptions and opinions about a program or process, self-efficacy can adversely affect a person's willingness to engage with a challenge and persevere with change agendas.

Educational change agendas supported by coaching rely on positive self-efficacy and motivation of teachers in the classroom to enact improvement strategies (Glasswell, 2012; Matters, 2006; M. Tschannen-Moran & Hoy, 2001; Virgona, 2012). For a coaching program to integrate disciplinary literacy in mathematics successfully, the RC and teachers must be reflective, believe in their capability to positively influence student learning, and apply self-efficacy to their own learning (Bandura, 1977a; Nenni, 2011; M. Tschannen-Moran & Hoy, 2001; Williams, 2009). M. Tschannen-Moran and Hoy (2001) contend that teachers' efficacy beliefs directly influence the level of effort, perseverance, and resilience shown when faced with teaching and learning challenges. It is important to consider coaches' and teachers' self-efficacy, in terms of subject-matter knowledge or mathematics content, pedagogical content knowledge (Shulman, 1986), and the disciplinary literacy practices within mathematics.

Drawing a direct link between self-efficacy and PL through coaching, a research study conducted in the USA with middle and high school teachers combined a summer institute PD with follow-up coaching support (Nugent et al., 2016). Teachers in this study reported that their self-efficacy significantly improved due to the support and ongoing feedback from the RC while they implemented and practised new skills in their classrooms. A dual approach to PL such as this example reinforces the concept of theory plus demonstration and observation plus practice plus feedback plus classroom application and coaching (EIRC, 2021b, p. 4).

2.3.1 Self-Efficacy and Literacy Learning

The literature suggests that secondary teachers may be content experts but not necessarily literacy specialists and that this may influence their self-belief or identity as competent teachers (Fang, 2014; Wang et al., 2016). Secondary mathematics teachers may not have experienced learning about explicit reading instruction during their teacher training or in actual practice (Fang, 2014; Ippolito et al., 2017). This limitation might affect teachers' self-efficacy with regard to their individual notions of confidence with the subject matter (literacy/mathematics) and pedagogy, as well as a teaching team or group's perceived collective efficacy (Bandura, 2000). Ippolito et al. (2017) claim that "math teachers are least likely to be offered support in learning about,

designing, and refining disciplinary literacy practices, despite the highly specialised and prevalent literacy practices that math demands" (p. 67).

Ciampa and Gallagher's (2016) study of Year 8 and 9 teachers (with students aged 13–15 years) in the USA focused on collaborative inquiry and its impact on teachers' self-efficacy in literacy instruction. The researchers posed the question, "How has working collaboratively on an inquiry-based PD program impacted teachers' professional self-efficacy?" (Ciampa & Gallagher, 2016, p. 859). The results indicated that teachers believed not only in their collective capabilities as a team, but also in their individual self-efficacy, which, in turn, positively affected the collaborative process (Ciampa & Gallagher, 2016). These findings suggest that if groups of teachers can support and inspire each other to take risks, then professional CoPs can benefit both teachers and students.

2.4 Collective Efficacy

In the context of coaching and collaboration, participants who have positive self-efficacy could become valuable members of a team. The combined effect of a group's collective power to produce results, that is, their collective efficacy, is critical to successful outcomes (Bandura, 1982). To extend the notion of collective efficacy (Bandura, 1977a, 2000), the implications for teacher teams are significant. Bandura's social cognitive theory (2001), an expansion of their original work from 1977, proposed that the collective power of a group relies on the members' shared beliefs as well as their individual personal efficacy. Accordingly, the sum is not just a combination of its parts; rather, the dynamics and synergy of team members creates a more powerful and successful result if the participants have confidence, motivation, and resilience individually and collectively. Bandura (2000) notes that "it is not uncommon for groups with members who are talented individually to perform poorly collectively because the members cannot work well together as a unit" (p. 76).

In this research study, a coaching program was developed with the aim of being a supportive, positive, and collegial learning experience for teachers and a coach involved in a CoP. While Chapter 3, Section 3.2 explains the framework for this study in more detail, the connection between coaching styles, effective CoPs and collective efficacy is foreshadowed here. M. Tschannen-Moran and Hoy (2001) conducted empirical research into sources of teachers' self-efficacy beliefs and noted that verbal persuasion through

collegial support, and mastery experiences or satisfaction with previous successes, were two aspects which supported beginning teachers' self-efficacy beliefs. Members of the community play a key role in providing interpersonal support, particularly when the team comprises teachers with varying levels of experience.

In addition to the association between CoPs, collaboration, and collective efficacy, Knight's (2009, 2010) partnership principles of coaching include equality, choice, voice, reflection, dialogue, praxis, and reciprocity. As an example of the partnership approach, both the coach and each coachee share decision-making, work side by side, and learn from each other. The notion of working and learning together to develop efficacy underpins an effective coaching partnership.

With the knowledge that negative feedback has a damaging effect on self-efficacy, and people's experiences provide them with their perceptions of self-efficacy, the RC and teacher team had an imperative to promote collective agency by maintaining positive relationships within the CoP. Central to the development of an individual's beliefs about themselves is the notion that positive feedback builds self-efficacy, whereas negative feedback is more damaging and lowers self-efficacy (Bandura, 1982). A core understanding of positive feedback, coach and teacher self-efficacy, and collective efficacy was significant for this research. According to Bandura (2000), "perceived collective efficacy fosters groups' motivational commitment to their missions, resilience to adversity, and performance accomplishments" (p. 75). One intent of this research was for a CoP model to promote a successful collaborative approach to support more widespread teacher interest and engagement with subject-specific (disciplinary) literacy practices. For literacy to become equally as important as content knowledge, discussion must turn to the particular literacy practices inherent in the subject domains.

2.5 What Is Literacy?

This section broadly defines literacy, then the following section narrows the scope to focus on disciplinary literacy. Literacy can be considered an umbrella term which encompasses reading, writing, thinking, and doing (Brozo & Fisher, 2010; Fisher & Ivey, 2005; Israel & Duffy, 2009; Lent, 2016). To contextualise this research project about coaching and how it influences secondary mathematics teachers'

disciplinary literacy learning, it is important to understand the landscape of secondary school and adolescent literacy challenges.

The Australian Literacy Educators' Association (ALEA), a leading professional organisation, published a statement in 2015 addressing literacy in the 21st century in Australia. The statement, *The ALEA Declaration* (ALEA, 2015), promotes literacy as core to a functional society: "Literacy is a powerful, wide-ranging life skill beyond traditional notions of talking, listening, reading and writing" (p. 1). Central to this discussion of literacy is the acknowledgement that reading comprehension is a foundation skill and a measurable aspect of literacy. The development of reading for many children in Australia begins at birth and continues through to secondary school and into adulthood. Reading proficiency is assessed at different junctures (school, national, international), and because aspects of reading can be assessed and benchmarked, it draws particular attention from policymakers, governments, and researchers (DEA, 2006; DET, 2016).

While debate about the complexities of literacy continues, some research has revealed that reading comprehension programs boost student performance across the content areas (Fisher & Frey, 2012; Pearson & Gallagher, 1983; C. Shanahan et al., 2011). This indicates that aspects of reading such as comprehension might be associated with the improvement of literacy skills more broadly. This project recognises the importance of reading but views literacy as a term which describes a broad range of communication skills.

The Australian Curriculum defines literacy comprehensively, which is stated here as follows:

> Literacy encompasses the knowledge and skills students need to access, understand, analyse and evaluate information, make meaning, express thoughts and emotions, present ideas and opinions, interact with others and participate in activities at school and in their lives beyond school. Success in any learning area depends on being able to use the significant, identifiable and distinctive literacy that is important for learning and representative of the content of that learning area. (ACARA, 2021a, para. 2)

More specifically, the general capabilities of the Australian Curriculum version 8.4, under which this study was conducted (ACARA, 2021a), state that each subject area or discipline has unique literacy requirements: "Success in any learning area

depends on being able to use the significant, identifiable and distinctive literacy that is important for learning and representative of the content of that learning area" (para. 2). This understanding about literacy aligns more with the notion of disciplinary literacies and has further implications for teachers in Australia responsible for the implementation of the Australian Curriculum.

2.6 Disciplinary Literacy

Throughout this research project the term *disciplinary literacy* refers to the particular receptive and productive skills required to access discipline-specific content, which is the literacy of a particular subject or domain (Dobbs et al., 2017; Elish-Piper et al., 2016; Goldman, 2012; Hynd-Shanahan, 2013; Lent, 2016; Moje, 2007; T. Shanahan & Shanahan, 2008). Dobbs et al. (2017) state that "having strong literacy skills in various disciplinary classrooms opens doors for students" (p. 13). Disciplinary literacy practices have evolved from a more general, content-area reading instruction "strategies" approach in the 1980s and 1990s.

Early proponents of content-area literacies produced resource books of strategies which provided teachers with lists of cross-curricula literacy tools (Fisher et al., 2011; Fisher & Frey, 2012; Lapp et al., 2004; Rapp Ruddell, 2008). For example, such approaches include Cornell note taking for summarising, graphic organisers for making connections like cause/effect, or strategies to increase subject-specific vocabulary (Fisher et al., 2011; Frey, 2011). Practical resources for applying generic skills have their place (Lapp et al., 2004). Indeed, it could be argued that generic strategies can be applied across many content areas with reasonable effect, and in many cases, the consistent application of key strategies can support student learning across the curriculum (Hattie, 2015). However, Hannant and Jetnikoff (2015) contend that generic content strategies in reading lack the rigour required in specific disciplines like history, mathematics, and science. Dobbs et al. (2017) note that each day, students move between the various disciplines, having to "rapidly adopt and then shift discipline-specific ways of communicating" (p. 13). This idea is explored further in Section 2.6.1, Mathematical Literacy.

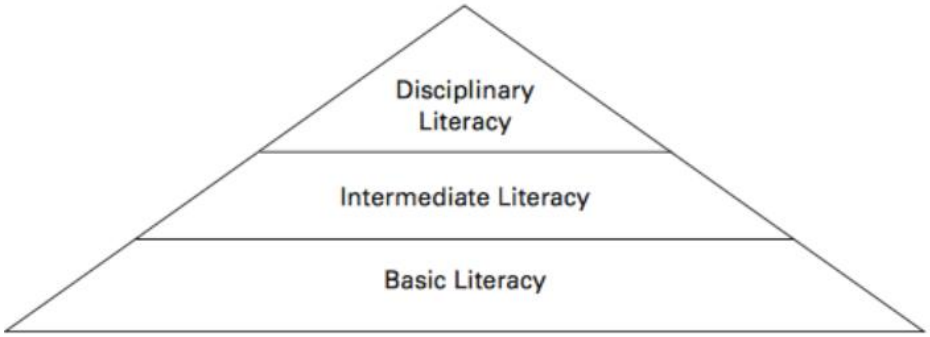
Researchers such as Moje (2007, 2008), Hannant and Jetnikoff (2015), and Lee (2014) have delved into the fabric of society, culture, and discipline discourses in order to reconceptualise disciplinary literacy (Moje, 2007, 2008). T. Shanahan and Shanahan

(2015) have led the disciplinary literacy push in the USA since the late 2000s, and their analogy of disciplinary literacy as a "distant cousin to content area literacy" (p. 11) shows a relationship between the two. They argue that content literacy strategies work to boost students' general reading and writing skills, whereas disciplinary literacy practices are more concerned with specialised skills within each discipline. "Thus, the purpose of disciplinary literacy is less about trying to give students the tools (for example, study skills) to be better students generally, and more about inducting them into the disciplines" (T. Shanahan & Shanahan, 2015, p. 12). Moje (2008) also proposes a reconceptualisation of disciplinary literacy, moving away from sets of strategies to help students engage with texts, towards learning different knowledge and ways of knowing, doing, and communicating. Her approach advocates the design and creation of disciplinary literacy programs of study, rather than teaching content teachers how to overlay literacy practices and strategies.

T. Shanahan and Shanahan's (2008) pyramid model represents a progression from basic literacy skills at the base, to intermediate literacy, and finally disciplinary literacy (Figure 2.1). This figure represents the incremental progression towards more precise literacy skills as students develop through the phases of schooling into more disciplinary-focused learning contexts.

Figure 2.1

The Increasing Specialisation of Literacy Development



Note. From "Teaching Disciplinary Literacy to Adolescents: Rethinking Content-Area Literacy," by T. Shanahan and C. Shanahan, 2008, Harvard Educational Review, *78*(1), p. 44 (https://doi.org/10.17763/haer.78.1.v62444321p602101). Copyright 2008 by the President and Fellows of Harvard College. Reprinted with permission.

Basic literacy, at the base of the model, represents early development of sounds, words, and comprehension skills in the early years of school, that is, children up to approximately Year 3 (around 7 years of age). Intermediate literacy represents the development of content-area strategies and skills, which for most children have developed during upper primary to junior secondary (8 to 13 years of age). Elish-Piper at al. (2016) refer to content-area strategies as helping to "provide a baseline of comprehension" (p. 3). Intermediate literacy skills include basic comprehension strategies, writing, and vocabulary development – the generic, content-area strategies previously outlined (Dobbs et al., 2017; Elish-Piper et al., 2016; T. Shanahan & Shanahan, 2008).

The increased specialisation of discipline-specific literacies which students typically encounter in secondary school is shown at the tip of the pyramid, where the model narrows (Dobbs et al., 2017; Elish-Piper et al., 2016; T. Shanahan & Shanahan, 2008). This is where T. Shanahan and Shanahan (2008) indicate students require "more sophisticated but less generalizable skills and routines" (p. 45). While students may not become experts in every discipline, their ability to read and comprehend discipline-specific texts is required for success in school (Elish-Piper et al., 2016).

Disciplinary literacy instruction has emerged as a possible solution to adolescent reading concerns (Fang, 2014; Lee, 2014; Lee & Spratley, 2010; Moje, 2008; T. Shanahan & Shanahan, 2008). Researchers have devoted significant time and research to adolescent literacy due to a transition which occurs at the upper primary/middle school juncture (around Year 5–6), where literacy learning shifts from learning to read, to reading to learn (Goldman, 2012; Lee & Spratley, 2010). Over time, particularly the past three decades, growing awareness of the complexity and uniqueness of disciplinary literacies is evident in the literature. Eminent researchers and writers within the field acknowledge the embeddedness of social, cultural, and technological aspects of a discipline, along with the more familiar operational skills like reading, writing, thinking, and doing (Fang & Coatam, 2013; Hynd-Shanahan, 2013; Lee & Spratley, 2010; Meiers, 2015; Moje, 2008; T. Shanahan & Shanahan, 2008). Fang (2014) asserts that "proponents of disciplinary literacy recommend that literacy instruction be anchored in the disciplines and advocate explicit attention to discipline-specific cognitive strategies, language skills, literate practices, and habits of mind" (p. 628).

Despite growing awareness of more refined literacy practices required in the disciplines, T. Shanahan and Shanahan's (2008) early work voiced concerns about a lack of explicit classroom literacy instruction at the highest level: "By the time adolescent students are being challenged by disciplinary texts, literacy instruction often has evaporated altogether" (p. 45). Other researchers have reported concerns with secondary teacher preparation for subject-specific literacy instruction (Brozo & Fisher, 2010; Fang, 2014; Goldman, 2012; Lee, 2014; Moje, 2008; C. Shanahan et al., 2011). Coaching could provide situated, contextual support for teachers to develop disciplinary teaching and learning awareness, in order to provide students entry into a particular discipline. If Moje's (2008) research in the design and creation of disciplinary literacy programs of study evidences a more appropriate way to approach disciplinary literacy learning for students, then the presence of coaches to support secondary teachers to implement a disciplinary literacy approach is crucial.

More recently, there has been a drive to embed disciplinary literacy endeavours to remove the perception of an extra burden of teaching literacy skills. Lent (2016) asserts that "we must ask disciplinary teachers to share the secrets of literacy that work in their content areas" (p. 14). More specifically, she warns against the "disenfranchisement of mathematics teachers" (p. 17), who have been desperately trying to insert reading activities into mathematics lessons, instead of consulting teachers about "what literacy looks like in their discipline" (Lent, 2016, p. 17).

While support in the literature is strong for disciplinary literacies and subject-specific reading, some researchers believe secondary schools should maintain content-area strategies, those generic skills likely to have been taught explicitly in primary school. Fagella-Luby et al. (2012) contend that generic reading comprehension skills (predicting, visualising, questioning, making connections, inferring) provide students with foundational skills, before disciplinary literacy can improve knowledge and understanding in a specific subject. Fagella-Luby et al. (2012) maintain that the current range of learners in classrooms means teachers must account for diverse readers – those who may not be aligned with year-level expectations, alongside proficient readers. To counter this, Dobbs et al. (2017) argue that it makes sense to train teachers in the disciplines, incorporating the disciplinary ways of knowing and communicating as a core part of content instruction. Ideally, literacy strategies should combine with content delivery to support the challenges of reading in each learning area due to the

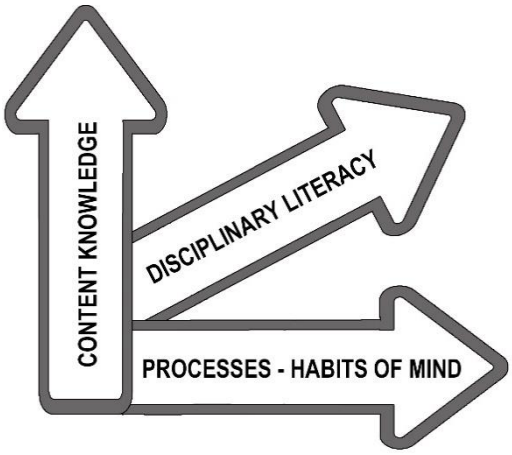
complexity of the disciplinary literacy skills required with more complex texts, and thinking at higher levels of education (Fang, 2014; T. Shanahan & Shanahan, 2008, 2012; Stewart-Dore, 2013).

Secondary students are more likely to be taught by a content-area specialist, and, as previously noted, many secondary teachers are not specifically trained to teach literacy in their subject (Brozo & Fisher, 2010; Fang, 2014; Lee, 2014; Moje, 2008; C. Shanahan et al., 2011). Goldman (2012) argues that most teachers outside the English domain are unaware of the need to teach literacy, and most middle years and secondary teachers do not place equal weight on the teaching of both disciplinary content and disciplinary literacy. Secondary school students are faced with learning the content of each subject or discipline, along with the particular 'habits of mind' for each discipline; those habits which help students think about a subject the way the experts do (Lim & Selden 2010). Dobbs et al. (2017) acknowledge the challenges for secondary teachers, noting that disciplinary literacy instruction does not come as a pre-packaged curriculum resource as a simple solution for change. For teachers to adopt or adapt classroom practices, gradual and supportive processes must be developed.

To address concerns about the quality of disciplinary content taught in secondary schools, a significant body of disciplinary literacy research promotes the concept of teaching and learning on the diagonal (Di Domenico, 2014; Elish-Piper, 2018; Elish-Piper et al., 2016). As illustrated in Figure 2.2, an oblique line represents a balance between developing the vertical axis of content knowledge and the horizontal axis which represents "habits of mind in a discipline" (Di Domenico, 2014; Elish-Piper, 2018; Elish-Piper et al., 2016, p. 6). Elish-Piper (2018) includes the development of habits of mind as ways of investigating, reasoning, reading, writing, talking, and problem-solving in a discipline. Based upon earlier work by Geisler (1994) and McConachie and Petrosky (2010), this model advances the idea that secondary teachers model their discipline's literacies (the processes, or habits of mind) while simultaneously imparting knowledge of core content and concepts (Di Domenico, 2014; Elish-Piper, 2018). Further to the concept of *teaching* on the diagonal is the notion of secondary students *learning* on the diagonal. For teaching and learning on the diagonal to occur, teachers should know and model expert practices for students.

Figure 2.2

Teaching and Learning on the Diagonal



Note. Adapted from *Disciplinary Literacy Coaching for Teachers in Secondary Schools* (slide 9), by L. Elish-Piper, 2018, Keynote presentation at Taiwan Educational Research Association and the Global Society of Chinese Creativity International Conference, Kaohsiung, Taiwan, November 8–11, 2018. Copyright 2018 by L. Elish-Piper. Adapted with permission.

Di Domenico (2014) questions whether secondary school teachers are disciplinary experts in their field, as a result of her empirical research into secondary school teachers' disciplinary knowledge across the four major disciplines of English, science, mathematics, and social studies. Many structures surround teachers, for example, external or top-down factors such as the prescribed curriculum, assessment, and reporting processes, together with internal school-based aspects like a pedagogical framework. These factors control and guide decisions about what to teach, when to teach it, and how it should be taught. Despite this, Di Domenico (2014) found that teachers in her study had varying levels of knowledge and understanding of disciplinary literacy. Her research showed teachers had not yet integrated their knowledge into planned instruction. Another significant challenge faced by many schools is the proportion of teachers who are not actually teaching in their content area, that is, they are teaching out-of-field.

Across Australia, some secondary teachers are assigned to teach subjects for which they have not been trained (ATWD, 2021). Hobbs and Porsch (2021) outline constraints within educational systems such as teacher shortages, timetabling of subjects, funding models, and the fact that most secondary teacher training is focused

on one or two subject specialisations. “Teaching out-of-field occurs mainly because we do not have the teachers in the system that match the subjects taught in schools” (Hobbs & Porsch, 2021, p. 601). Vale, Campbell & White (2020) contend that the incidence of out-of-field teaching is higher in low socio-economic communities or rural and remote areas in Australia. The term *out-of-field* is internationally recognised (Goos & Gyerin, 2021; Vale, Campbell & White, 2020), and relates to teachers working outside their formal training area. These terms, out-of-field and in-field, are noted in the ATWD report (ATWD, 2021), which collects data related to the composition of the Australian teaching workforce and have been paraphrased as follows: teaching in-field refers to teaching subjects in which teachers have been trained; teaching out-of-field refers to teaching subjects in which a teacher has not been formally trained (ATWD, 2021).

Some teachers have engaged in further PL to extend their undergraduate training, while others may not have had access to formal learning but still be required to teach a subject outside their formal qualifications. Compared with the subject of English, in which 18% of Australian secondary teachers were considered to be out-of-field, mathematics had 24% of teachers with “no training” in the subject and 16% of teachers who had received content or pedagogy training (ATWD, 2021, p. 89). Goos and Guerin (2021) compared the pedagogical practices of mathematics teachers from within their field, with teachers who had been upskilled, and teachers who were completely out-of-field. The researchers determined that programs which support the upskilling of teachers reap benefits. The upskilled teachers began to develop pedagogical practices “more like those of in-field teachers” (Goos & Guerin, 2021, p. 203.). Empirical research such as this strongly suggests that targeted PL programs like coaching may be warranted as an approach for teachers.

The next section explores the disciplinary literacies of mathematics, examining complexities for teachers and challenges for students.

2.6.1 Mathematical Literacy

This section examines the literature in the fields of reading and problem-solving in mathematics, mathematical discourse, and thinking in mathematics, and the particular challenges these pose for teachers and students. This research is important for the current study, as mathematics teachers may be more prepared to teach subject

content rather than disciplinary literacies (Brozo & Fisher, 2010; Fang, 2014; Lee, 2014; Moje, 2008; C. Shanahan et al., 2011). For some, literacy coaching and mathematics may not traditionally go together; however, understanding the nature and purpose of literacy in the discipline of mathematics could improve literacy practices in this subject area and thereby improve overall learning of mathematics. Within the Australian Curriculum version 8.4, literacy is considered a general capability and embedded in every discipline. "Success in any learning area depends on being able to use the significant, identifiable and distinctive literacy that is important for learning and representative of the content of that learning area" (ACARA, 2021a, para. 2).

The rationale from all of the Queensland Curriculum and Assessment Authority (QCAA) Mathematics senior syllabi (version 1.2) begins by stating the following:

> Mathematics is a unique and powerful intellectual discipline that is used to investigate patterns, order, generality and uncertainty. It is a way of thinking in which problems are explored and solved through observation, reflection and logical reasoning. It uses a concise system of communication, with written, symbolic, spoken and visual components. Mathematics is creative, requires initiative and promotes curiosity in an increasingly complex and data-driven world. It is the foundation of all quantitative disciplines. (QCAA, 2019, p. 1)

Mathematical literacy is defined by PISA as follows:

> Mathematical literacy is … an individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded judgements and to use and engage with mathematics in ways that meet the needs of that individual's life as a constructive, concerned and reflective citizen. (UNESCO International Bureau of Education, n.d., para. 1)

The current study recognises the capacity to operate mathematically; however, using a lens to identify the disciplinary literacies in mathematics foregrounds the skills of reading comprehension, vocabulary knowledge, oral language, communication, and writing. In order to demonstrate mathematical literacy, students should learn and use the particular literacies of the discipline.

For some mathematics teachers, understanding disciplinary literacies may present a challenge; as with many teaching areas, people are often drawn to subjects where they have experienced success. Dobbs et al. (2017) propose that some teachers may find it "difficult to name and reveal those ways of thinking and working to

students, who may not experience the same natural inclination toward particular disciplines" (p. 108). Further discussion in Section 2.6.1.4 will focus on the specific habits of thinking, valued texts, and ways of working in mathematics.

2.6.1.1 Reading, Vocabulary, and Language in Mathematics

In order for students to read and comprehend in mathematics, they must first develop skills in reading, vocabulary, and language in mathematics. Attard's (2022) webinar address to the Primary English Teaching Association Australia (PETAA) reinforced the need to support students' literacy and numeracy foundations when she stated, "we can't do maths if we're not literate" (3:44). Research into teaching reading in content areas (the various disciplines or subject areas) reveals that specialist teachers, particularly in secondary schools, have been encouraged to include reading as part of classroom instructional practices; however, some teachers have resisted this due to the perception that it takes too long and they are time poor or due to a lack of training in teaching students to read (Brozo & Fisher, 2010; Fang, 2014; Hall, 2005). Bossé and Faulconer (2008) note that even if students can read the mathematics question, they may not be able to interpret or understand the meaning. Barton and Heidema (2000) identify familiar reading skills, as taught in English, for mathematics reading, such as decoding, monitoring, using prior knowledge and experiences, and making inferences. Thinking aloud is a comprehension strategy widely used by classroom teachers and taught to students to help them monitor their understanding when reading (Baumann et al., 1993). However, where mathematics reading differs from other subjects is the way students must also be able to read left to right and right to left, top to bottom, and diagonally. For example, when using number lines, one must be able to move laterally; when reading tables, the eyes move up and down, and graphs require diagonal reading and interpreting (Barton & Heidema, 2000). Expert mathematics readers are able to read spatially and iteratively, that is, moving between visuals, tables, words, symbols, and labels, all parts of the text having equal importance (Bossé & Faulconer, 2008). To contrast, reading a novel in literature would be considered a more linear reading task.

C. Shanahan et al. (2011) conducted analysis of expert readers in history, mathematics, and chemistry to determine the "educationally relevant differences in literacy use among three subject-matter disciplines" (p. 393). This research was an attempt to inform approaches for pre-service secondary teaching methods, and to

develop and trial disciplinary literacy procedures in high school classes. C. Shanahan et al. (2011) contend that reading and writing efforts to prepare secondary pre-service teachers are more content-area focused rather than discipline-specific. They use the term "general reading comprehension or study skills strategies" (p. 394). C. Shanahan et al. (2011) posited that "disciplinary experts read differently than novices" (p. 395) and were interested in the mathematics reading domain as it has been under-researched at the expert reading level. A key finding was that expert mathematicians did not distinguish between text features, the equations and words, but rather, "the two elements appeared to be treated as unified and of equal importance" (C. Shanahan et al., 2011, p. 418). The researchers noted this may be due to the way mathematics questions are often presented as alternating between "prose-equations-prose" (p. 418). The experts referred to all ideas in mathematics texts as "sentences or concepts" (p. 418), and they rarely separated ideas from equations or words alone. Another key finding was the way mathematics experts focused on the accuracy or "correctness of information" (C. Shanahan et al., 2011, p. 419) and were interested in internal consistency and identifying errors due to the importance of every word and the way words are specifically chosen to represent meaning.

Expert mathematicians in the C. Shanahan et al. (2011) research recommended a re-reading or close reading strategy in mathematics classrooms. Close reading is described as "an approach to teaching comprehension that insists students extract meaning from text by examining carefully how language is used in the passage itself" (Snow & O'Connor, 2016, p. 1). Close reading is introduced to participants in this study through the coaching program. Evidence of its use by participants is detailed in the findings and discussion, Section 5.3.2. C. Shanahan et al. (2011) noted that the mathematics experts "always took markedly more time than the other readers", and "reading and re-reading were the strategies they said they used and also the ones they wanted students to use" (p. 420). Support for close reading as a strategy relates to the way it challenges students, thus making them struggle, which is a process that can help readers. Fisher et al. (2016) note four elements of close reading: repeated reading of a short text; annotation of text to reflect thinking; some teacher questioning as a guide; and student discussion and analysis. Fang (2016) emphasises the opportunity for students to undertake multiple readings of a text, and the way re-reading, annotating, and discussion support deeper understanding of texts.

The Three Read Protocol (San Francisco Unified School District Mathematics Department, 2015) is a strategy for close reading in mathematics, used to engage students in worded problem-solving. Three reads can be considered a disciplinary literacy approach to mathematics reading, as it can be applied to simple or complex mathematics questions, usually worded problems. The experience of students will determine the level of involvement of the teacher. For example, students newer to the model may be led by the teacher throughout the three steps, whereas students familiar with the protocol could take responsibility for each step. The first read provides information about the context; this could be read aloud by the teacher or independently by the student. The first question is posed: "What is this about?" The second read is to identify aspects of mathematics such as numbers, quantities, information in worded form, and to answer "What are the quantities?" in the question. At this stage students may be able to annotate formulas or rules which apply. When working with a peer, discussion would occur to share key information, guided by the teacher if required. The third read is to determine what the question is asking the student to do: "What mathematical questions can we ask?" This would be followed by solving and working out either collaboratively or individually.

Another example of an iterative reading process similar to the notion of close reading in mathematics is a mnemonic device called CUBES (see Tibbitt, 2016). Mnemonic devices such as CUBES are taught to students in mathematics to support their ability to identify key information to interpret word problems. The acronym stands for: "C", circle important numbers; "U", underline the question; "B", box the key mathematics words; "E", evaluate, and eliminate unnecessary information; and "S", solve by showing your work. Research by Tibbitt (2016) showed that problem solving strategies can improve student problem-solving skills. Tibbitt's (2016) study compared two problem solving strategies, CUBES and one other, and noted that there is no official academic source for CUBES. It is a device seemingly shared between teachers to support student problem solving. Using a device such as CUBES helps students identify and understand the language patterns and text structures of worded problems. It could be a starting point to build students' confidence and independence, encouraging them to re-read and annotate texts independently.

Understanding vocabulary, terminology, and text structure is fundamental to comprehension. Barton et al. (2002) state that to learn about mathematics vocabulary,

students need to construct meaning for mathematics vocabulary and key terms, with multiple opportunities to understand related concepts; looking up word definitions is not sufficient. The practice of creating non-linguistic representations using graphics and images has been shown to support students to construct meaning and comprehension, along with graphic organisers, mind maps, and spatial representations to reinforce deep learning (Barton et al., 2002). Stahl (1986) reviewed different vocabulary instruction methods and proposed three principles: give both context and definitions; encourage deep processing through connections with known information or other meanings; and give students multiple exposures to new vocabulary. In terms of text structure, there is a significant difference between language arts texts (those text types encountered in subjects like English or the humanities) and mathematics or science texts. For example, the main idea or theme in an expository paragraph would usually be at the beginning, in the first or second (topic) sentence. In contrast, the main idea in a worded mathematics problem is usually at the end of the question, for example, "How many buttons of each shape does Sarah have?" The main idea is last instead of first in the text (Barton et al., 2002).

The literature about reading and processing in mathematics is considerable. A synthesis of some of these works reveals the complexity of mathematical language. Academic consensus routinely describes mathematics language as a unique entity with multiple modes (numbers, symbols, letters, diagrams), requiring sophisticated decoding and vocabulary knowledge (Adams, 2003; Doerr & Temple, 2016; Gough, 2007; Phillips et al., 2009; Quinnell & Carter, 2013). The *National Numeracy Review Report*, commissioned by the Council of Australian Governments (COAG, 2008), identifies a major issue relating to language and literacy in mathematics education, namely, "for many children, mathematics is seen as a 'foreign language'" (p. 32). Examples include the use of specialised symbols, everyday English words with completely different meanings in mathematics, and the need for language-based factors to support students when solving word problems (Meiers & Trevitt, 2010). Meiers and Trevitt (2010) acknowledge "the significant role of language in mathematics learning" (p. 2), which helps clarify literacy in mathematics, or "how students access mathematics through language" (p. 3). Implications for literacy knowledge for educators in this discipline are significant – teaching mathematics hinges on a teacher's ability to simultaneously teach disciplinary content and the

required literacy skills to access and learn within the discipline (Adams, 2003; Gough, 2007; Phillips et al., 2009; Quinnell & Carter, 2013).

As mathematical language seems to be widely accepted by the literature as complex and a barrier to student learning (Adams, 2003; Gough, 2007; Quinnell & Carter, 2013), it is important to differentiate reading and processing demands from other disciplines. Barton and Heidema (2000) demonstrate a unique aspect of mathematics reading when students must decode unfamiliar text. Usually readers try to sound out an unfamiliar word, as this is how language and vocabulary work in many other disciplines. However, sounding out does not help when faced with a symbol such as an operation, an arrow, or other pictorial representation. Barton and Heidema (2000) note the ways other mathematics visuals, for example diagrams or graphs, are difficult for students to express in words, and the way pictures of shapes can vary widely but still represent a three-sided figure know as a triangle. Students may become confused between directions in a question, particularly if terms or concepts have been previously learned and not used again for a period of time(Barton & Heidema, 2000).

Adams (2003) argues that words used in mathematics have multiple meanings, and compares terms like *ruler*, *cubed*, *face*, and *range* to emphasise both the mathematical meaning and the everyday meaning. Gough (2007) concurs, and believes that mathematics is an "artificially constructed language" (p. 8). He asserts that problems arise when a term is considered technical language in the mathematics classroom but bears an everyday meaning elsewhere, and highlights the proliferation of spatial terms (higher, lower, up, down, etc.) and some Greek and Latin roots which can act in conceptually different ways for students. Mathematics is further complicated by symbols, abbreviations, and pronumerals or letters used to represent numbers (Quinnell & Carter, 2013). According to Lent (2016), "mathematical literacy involves patterns, relationships, and examples of understanding through visuals or abstract representations. Not only do mathematicians read differently than those in other disciplines, but they use what they are reading in different ways" (p. 17).

Another challenge highlighted by mathematical literacy researchers is the lack of consistency when representing symbols and abbreviations used in mathematics problems. Examples taken from NAPLAN questions reinforce the foreign language analogy from the COAG (2008) report (Exley & Trimble-Roles, 2016; Quinnell & Carter, 2013). Quinnell and Carter (2013) point to the use of abbreviations (e.g., cm,

mm, N for north, and 3D for three-dimensional), which may not be used consistently in the same test paper or across multiple years. Likewise, Exley and Trimble-Roles (2016) argue that NAPLAN Year 3 mathematics questions expect 7- and 8-year-old students to comprehend worded questions containing pronouns and noun groups using skills from Year 4 standards in the Australian Curriculum. This could impact students' ability to access the mathematics questions with reasonable expectations.

Assessment tasks are not just used diagnostically (NAPLAN or PAT-M) but embedded within each unit of work. Formative assessment may be used progressively to monitor and check student understanding; however, most units culminate with a more extended, summative assessment task. Abedi and Lord (2001) researched the importance of understanding language in assessment tasks for English language learners (ELLs). Their study noted discrepancies on worded problems between proficient language speakers and ELL students, and once linguistic features were modified on some tasks, students were better able to comprehend questions. For example, when the number of unfamiliar or non-mathematics words in a question was changed, or passive voice verbs were changed to active voice, ELL students were more likely to access the mathematics concepts in each question (Abedi & Lord, 2001). When considering the diversity of students in every classroom, it is worth emphasising that students with other language backgrounds, that is, English as an additional language or dialect (EAL/D), as well as ELLs, may face barriers with symbols, word problems, grammar, and local conventions that are not implemented consistently across a global discipline (Quinnell & Carter, 2013).

2.6.1.2 Problem-Solving in Mathematics

Problem-solving is one of four mathematics proficiency strands in the Australian Curriculum (ACARA, 2021c):

> Students develop the ability to make choices, interpret, formulate, model and investigate problem situations, and communicate solutions effectively. Students formulate and solve problems when they use mathematics to represent unfamiliar or meaningful situations, when they design investigations and plan their approaches, when they apply their existing strategies to seek solutions, and when they verify that their answers are reasonable. (ACARA, 2021c, Problem-Solving section)

When solving mathematics problems, students must apply their knowledge of mathematical concepts and operations (Kaur, 1997). This is complex and challenging and involves a number of cognitive processes, including a student's previous experience, mathematics knowledge, and literacy level. Kaur (1997) argues that problem-solving involves the coordination of higher order thinking and processing unique to each problem. Kaur (1997) highlights the work of Schoenfeld (1992), who compared ways that expert and novice problem solvers differed; for example, "good problem solvers tend to focus their attention on structural features of problems while poor problem solvers focus on surface features" (Schoenfeld, 1985, 1987, as cited in Kaur, 1997, p. 96). Schoenfeld (1992) states that "learning mathematics is empowering" (p. 337), and students who can apply mathematics practically to the simplest of tasks or more complex applications will make better decisions.

Word problems are types of mathematical exercises which contain information in words, usually accompanied by mathematical notation such as numerals and symbols. Problems of this type can be categorised according to the level of complexity or number of operations and steps required to find a solution. The QCAA senior syllabi present teachers and students with definitions in the glossary of terms to provide clarity about the complexity of problems. For example, in the Essential Mathematics (QCAA, 2022) glossary, the term 'simple familiar' relates to problems which require simple subject matter knowledge, the procedure is clear, and an expectation that the classroom context has provided opportunities for prior learning. In contrast, a 'complex unfamiliar' problem would require knowledge of complex subject matter, and the ability to interpret the given information to apply the procedure to solve it, with limited classroom practice or prior experience. Other problem types include open and closed questions, where open-ended tasks present learners with cognitive development and opportunities to challenge mathematical thinking as instead of one, routine solution; there are multiple ways the open problem can be approached and solved (Sullivan, Warren & White, 2000).

The QCAA promotes a four-stage approach to problem-solving and mathematical modelling: formulate, solve, evaluate and verify, and communicate (QCAA, 2019, p. 14). Each stage in this model represents four key criteria on each instrument-specific marking guide in Year 11 and Year 12 problem-solving assessment tasks. A fully annotated, four-stage model in the form of a flowchart (QCAA, 2019, p. 14) is included

in each of the following senior mathematics syllabi: General Mathematics, Essential Mathematics, Mathematical Methods, Specialist Mathematics, and the Numeracy short course (QCAA, 2022). While other mathematical frameworks and models are acknowledged in the QCAA syllabi, the QCAA (2019) notes this four-stage approach aligns with Polya's (1957) four-step process. Heidema (2009) notes that Polya's (1957) flowchart model underpins a range of problem-solving strategies taught to students in primary and secondary schools. Ortiz (2016) states that a model such as Polya's (1957), namely, understanding the problem, devising a plan, carrying out the plan, and looking back (p. 2), does not necessarily make students better mathematicians. Ortiz (2016) argues that such an approach may not support real-life situations as "only textbook word problems are found already neatly set up for you" (p. 9). While the model could support students to methodically address word problems, it may be the case that it inhibits creativity or dissuades students from thinking flexibly (Ortiz, 2016).

Worded problem-solving questions may challenge students to read and interpret words, symbols, and graphical elements, often requiring students to perform multiple steps, show their working, and explain their reasoning. For some students, worded mathematics problems create anxiety (Luttenberger et al., 2018). If students have performed poorly in the past, this may contribute to mathematics anxiety, and coupled with other factors such as low motivation or language barriers, could lead to long-term implications for performance. Students with literacy learning difficulties or EAL/D backgrounds typically engage mainly with numbers and avoid written language, thus missing valuable worded information in a problem (Attard, 2022). Luttenberger et al. (2018) define mathematics anxiety as "increased levels of anxiety in math-related situations" (p. 312). Interestingly, mathematics-anxious people may feel tense, apprehensive, or nervous, and their working memory can also be affected, which can lead to lower achievement (Luttenberger et al., 2018). The researchers note some practical ways for teachers to address this, for example, using humour, breaking large exams into smaller tasks, or introducing strategies to interest and motivate (Luttenberger et al., 2018). Connections between mathematics anxiety and fixed mindset are considered in Section 2.7.4.

2.6.1.3 Mathematical discourse

Mathematical discourse has been described as the social practice of language in mathematics. The term discourse "has had a complex history and it is used in a range of

different ways by different theorists" (Mills, 2004, p. 6). Derived from Foucault's (1972) work, discourse has been studied widely. Implementing mathematics discourse into the classroom aligns with social learning opportunities for teachers and students to engage and learn collaboratively through communication. In the USA, the National Council of Teachers of Mathematics (NCTM, 2010) collated manuscripts dedicated to supporting and sharing discourse practices for middle school teachers (teaching students aged 10–14 years). The collection of resources covered topics such as developing open-ended questions; shifting from the teacher as the source of questions and ideas towards students taking responsibility for learning; observation tools with protocols for lesson observations; and checklists to identify what is, and what is not, discourse.

Communication and social learning opportunities are the key to mathematical discourse (Ewing et al., 2011). Gough (2007) recommends teachers "use student talking to negotiate and construct correct understanding" (p. 7) to help strengthen knowledge and address misconceptions. Gough (2007) argues that "progressive shaping or refining" through language helps correct early thinking and support students to think and work more mathematically. When students are engaged in constructing their own mathematical understanding, for example, understanding key terms by creating non-linguistic representations and then explaining their learning to peers, effective communication and social learning can occur. Brown and Renshaw (2004) argue that despite the challenges of classroom teaching, mathematics teachers must be focused on helping students to link "everyday ways of knowing and doing with mathematical ways of knowing and doing" (p. 135). Brown and Renshaw's (2004) study noted the importance of student academic talk to promote deep understanding and opportunities for students to engage in a broad range of topics. More discussion about social learning and the theoretical framework of the study will be provided in Chapter 3.

As previously discussed by Fagella-Luby et al. (2012), some secondary school students may not have full access to the demands of the curriculum without acquiring the unique language and literacy skills of the discipline. According to Fagella-Luby et al. (2012), an intermediate level of literacy skill, which includes generic comprehension strategies, vocabulary development, and reading fluency, is developed by the end of middle school, or 14 years of age. The specialisation of subject-area reading, or discipline-specific literacy skills, is deemed by Fagella-Luby et al. (2012) as the province of secondary school, that is, students between 15 and 18 years of age.

The important consideration for secondary school teachers is the diverse range of reading abilities in any class. In line with a disciplinary literacy approach, reading in mathematics requires precision and perseverance; skimming, close reading, and checking necessitate that students re-read two or three times (Doerr & Temple, 2016; C. Shanahan et al., 2011). These skills and strategies can be explicitly taught to improve disciplinary literacy.

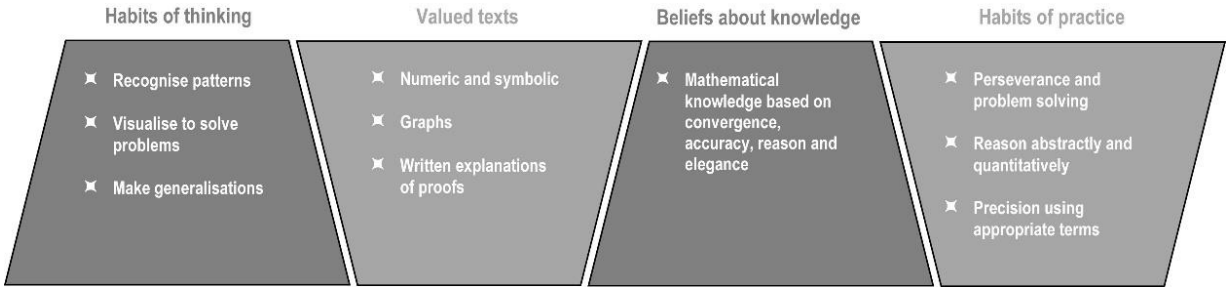
Brozo et al. (2013) advocate for a "blend of practices from both approaches" (p. 354) to support adolescent learning, in a call for researchers and teachers to combine the outside-in practices of content strategies with more internally developed disciplinary literacies. Within this study, contextualising mathematical literacies provided robust conversation in a CoP for teachers working in both junior secondary (Years 7, 8, 9) and senior secondary (Years 10, 11, 12).

2.6.1.4 Habits of Thinking and Working in Mathematics

To explore the notion of disciplinary literacies and unique practices in each subject, disciplinary literacy researchers such as Dobbs et al. (2017) and Elish-Piper (2018) have created useful frameworks to represent habits of thinking, valued texts, practices (including text types and writing), and "beliefs about knowledge" (Elish-Piper, 2018) for the main subject areas of mathematics, English/language arts, science, and social studies/history. Elish-Piper (2018) states that mathematical habits of thinking include recognising patterns, visualising (both mentally and in writing), and making generalisations (see Figure 2.3). In contrast to the disciplinary literacies of mathematics, the habits of thinking students may encounter in history/social studies include sourcing, contextualising, corroborating, and reconstructing the past (Elish-Piper, 2018). Dobbs et al. (2017) contend that "teaching disciplinary literacy skills at the secondary level welcomes students into a community of scholars within each discipline they encounter" (p. 20).

Figure 2.3

Disciplinary Literacy Practices in Math



Note. Adapted from *Disciplinary Literacy Coaching for Teachers in Secondary Schools* (slide 7), by L. Elish-Piper, 2018, Keynote presentation at Taiwan Educational Research Association and the Global Society of Chinese Creativity International Conference, Kaohsiung, Taiwan, November 8–11, 2018. Copyright 2018 by L. Elish-Piper. Adapted with permission.

Figure 2.3 presents the disciplinary literacy practices in mathematics, which incorporate the previously mentioned habits of thinking; types of valued texts such as graphs and numeric and symbolic representations; beliefs about mathematical knowledge such as accuracy, reason, and elegance; and the habits of practice used by mathematical experts. These habits include perseverance and problem solving, the ability to reason abstractly and quantitatively, and precision in using key terms and language (Elish-Piper, 2018).

Secondary teachers who engage in collaborative PL have opportunities to develop subject-specific literacy skills and a disciplinary literacy approach (Elish-Piper et al., 2016). The literature supports collaborative solutions to PL in schools, as the general belief that secondary school teachers are not necessarily well equipped to teach the literacy of their subject is well documented (Di Domenico, 2014; Donahue, 2003; Fang & Coatam, 2013; Phillips et al., 2009). Success in secondary disciplines such as geography, mathematics, history, and science all rely on specialist language, including vocabulary found mainly in that domain, for deep literacy learning (Gough, 2007; Phillips et al., 2009). A professional collaboration between the literacy coach and mathematics teachers could drive subject-specific literacy learning, which would be mutually beneficial for both teachers and students. A range of researchers advocate this approach (Dobbs et al., 2017; Doerr & Temple, 2016; Donahue, 2003; Elish-Piper, 2018; Elish-Piper et al., 2016; Fang & Coatam, 2013), reinforcing the significance of the current research, which advocates for a coaching/teaching relationship.

The next section details pedagogical considerations for this study.

2.7 Pedagogy

Pedagogy is central to disciplinary literacy learning and important when discussing teachers' experiences in the coaching program. This section discusses pedagogical considerations pertinent to this study for mathematics teaching and learning. These include pedagogical content knowledge (Shulman, 1986) and its derivatives (Hill et al., 2008); the gradual release of responsibility (GRR) framework (Fisher & Frey, 2013a, 2013b); collaborative and cooperative learning approaches (Kagan, 2007); mathematical mindset (Boaler, 2016; Dweck, 2008); and Maths as Storytelling (Matthews, 2018).

2.7.1 Pedagogical Content Knowledge

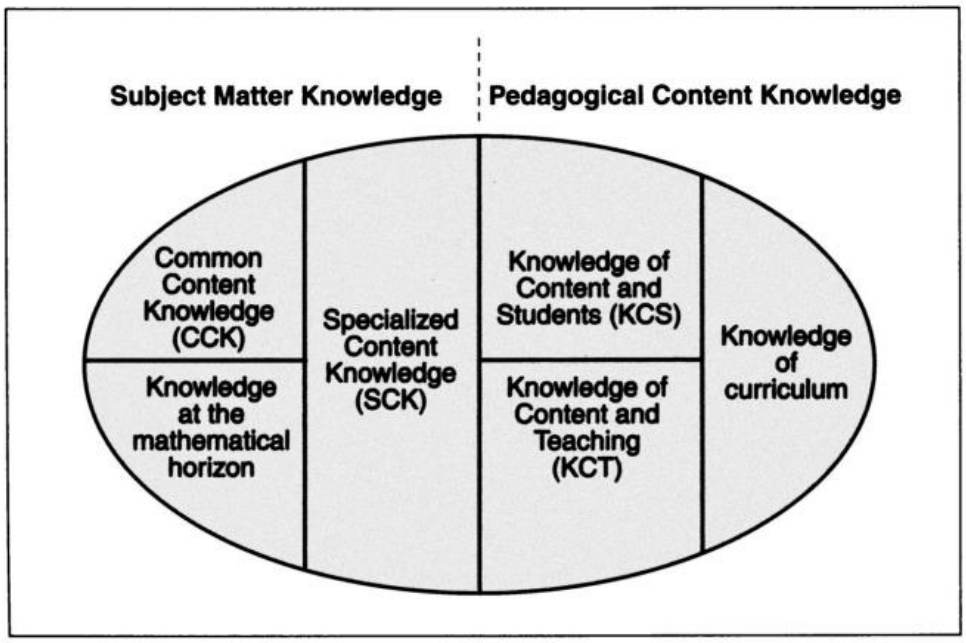
Shulman (1986) proposed the integration of subject-matter knowledge (the content) and the best ways to teach it to students (the pedagogy), known as pedagogical content knowledge (PCK). Shulman (1986) posed questions such as "Where do teacher explanations come from?" and "How do teachers decide what to teach, how to represent it, how to question students about it and how to deal with problems of misunderstanding?" (p. 8). These questions probe beyond disciplinary content knowledge to explore the ways in which teachers introduce topics, sequence and pace learning, and check for student understanding.

Hill et al. (2008) conducted research which built on Shulman's (1986) construct of PCK, expanding their focus to the discipline of mathematics. Hill et al. (2008) contend that "most scholars and policymakers have assumed that such knowledge [PCK] not only exists but also contributes to effective teaching and student learning" (p. 372). A domain map (see Figure 2.4) represents the relationship between mathematical subject-matter knowledge and PCK. PCK elements include knowledge of content and students (KCS), knowledge of content and teaching (KCT), and knowledge of curriculum. The researchers describe KCS as "content knowledge intertwined with knowledge of how students think about, know, or learn this particular content" (Hill et al., 2008, p. 375). Early research which informed the construct of KCS was based upon empirical evidence from mathematics teachers' observations,

rather than based upon a theory of learning. Hill et al.'s (2008) interpretation of subject-matter knowledge and PCK is represented in Figure 2.4.

Figure 2.4

Domain Map for Mathematical Knowledge for Teaching



Note. Reprinted with permission from "Unpacking Pedagogical Content Knowledge: Conceptualizing and Measuring Teachers' Topic-Specific Knowledge of Students," by H. C. Hill, D. Loewenberg Ball, & S. G. Schilling, 2008, *Journal for Research in Mathematics Education*, *39*(4), p. 377 (https://www.jstor.org/stable/40539304). Copyright 2008 by the National Council of Teachers of Mathematics. All rights reserved.

The left side of Figure 2.4 represents the relationship between different categories of subject-matter knowledge. These categories include more specific types of content knowledge, including common content knowledge, the more widely used mathematics knowledge found in other disciplines; specialised content knowledge, the discipline-specific mathematical content for teaching; and a category called "knowledge at the mathematical horizon". This latter category has been explained as the ways mathematics teachers know and understand how the current unit of study relates to and interacts with future mathematical learning, topics, and wider applications (Zazkis & Mamolo, 2011, p. 9).

2.7.2 Mathematical Mindset

Carol Dweck (2008) researched the influence of students' mindsets on their learning. Her work resonates with educators as it foregrounds the notion of a fixed or a growth mindset related to intellectual ability, which influences students' dispositions towards disciplines, particularly mathematics and science. Students who have a fixed mindset about mathematics or science ability believe they will never achieve success in these subjects, whereas the growth mindset students believe ability can be developed. Forty per cent of Dweck's (2008) research participants showed a fixed mindset. Interestingly, growth mindset participants also accounted for 40% of the group. Dweck's (2008) research noted that students were more likely to have a fixed mindset about mathematics skills than other abilities. Boaler (2016) addresses student mindset, encouraging mathematics teachers to adopt particular practices so that classroom pedagogies and instructional practices support students to adopt a growth mindset for mathematics.

A mathematics disciplinary lens is important if the tendency is for some students to show a fixed mindset in mathematics. A connection between mathematics anxiety, previously discussed in Section 2.6.1.2, and fixed mindset could be one reason why students who have experienced setbacks or poor performance in mathematics from an early age may be more susceptible to negative beliefs about their ability. Boaler (2016) relates a situation with preschool-age children where some already show a propensity to keep trying or give up; this behaviour is evident prior to the start of formal schooling. Boaler (2016) contends that mathematics should be an "open, growth, learning subject" (p. 180) as opposed to narrow and procedural, only moving students towards performing calculations and solving problems. "Mathematics tasks should offer plenty of space for learning. Instead of requiring that students simply give an answer, they should give students the opportunity to explore, create, and grow" (Boaler, 2016, p. 180).

2.7.3 Providing Context and Relevance

Widjaja (2013) contends that providing students with context and relevance supports mathematics learning. If a problem is well supported and provides students with a challenge, it can potentially elicit different interpretations and solutions. The main purpose for providing context is to engage learners, developing the background knowledge or purpose for learning new skills. Widjaja (2013) states that contextual

problems allow students an easier entry point, thus increasing access and engagement. By involving real-world contexts or increasing the relevance of a task to the learner, the student is potentially more likely to relate to the task and its processes. Widjaja (2013) argues that while this strategy is recommended for student engagement, it does not automatically guarantee students will be more motivated; however, there is potential for rich collaboration and social learning, and facilitated classroom discussions led by mathematics teachers.

2.7.4 Mathematics as Storytelling

Mathematics as Storytelling (MAST) is a five-step process for incorporating Indigenous perspectives into mathematics (Matthews, 2018). Devised to support underachieving students, its storytelling approach could be used in any classroom with students of all ages; the purpose of this method is to encourage students to visualise and incorporate visual elements (symbols) and equations with the intention of students creating their own symbols to represent meaning. Students are able to share and explain their symbols, building knowledge within the classroom community.

In the secondary school mathematics landscape, the work of mathematics teachers is complex. Teachers face many challenges, including creating a positive learning environment and meeting the demands of curriculum, assessment, and achievement. Coaching has become a timely and valued PL approach which supports teachers to address students' learning needs so that openness, creativity, and unique aspects of the discipline are accessible to all.

2.8 Conclusion

In summary, the findings of this literature review into teacher PL, coaching, self-efficacy, the disciplinary literacies of mathematics, and pedagogical considerations, provide context for this research project. Research which suggests secondary school teachers have varying knowledge of disciplinary literacies, coupled with high numbers of out-of-field teachers, reinforces the importance of studies that explore coaching and influences on secondary mathematics teachers' disciplinary literacy learning.

Coaching and collaborative approaches to learning have been implemented in schools as sustainable, embedded PL initiatives. Given the research base on the

benefits of coaching and collegial interaction within teaching teams such as CoPs, it was important to find out mathematics teachers' perceptions of coaching to foster disciplinary literacy.

The general capabilities in the Australian Curriculum version 8.4 clearly state that the responsibility of all teachers is to provide a comprehensive, subject-specific focus on the unique literacy of each learning area. This exploratory study of a school-based coaching program and how it fosters secondary mathematics teachers' disciplinary literacy learning reveals potentially valuable insights and fills a current gap in the body of knowledge around coaching and literacy learning in secondary schools. This research combines the values and principles of instructional coaching, whereby each individual teacher's choice, voice, and decisions are essential to the coaching relationship, with the collaborative skills and knowledge of disciplinary literacy to support instructional change. The next chapter provides the theoretical framework for the study.

Chapter 3: Theoretical Framework

The previous chapter addressed the overarching research question by reviewing and critiquing the research literature on PL for teachers, coaching in schools, self-efficacy, disciplinary literacy, pedagogy, and the claims and counter-claims over their effectiveness and impact in teaching and learning contexts. Particular attention was given to the elements of each one and the implications for mathematics teaching and learning. This chapter presents the theoretical framework that informed this study, a social theory of learning (Lave & Wenger, 1991; Wenger, 1998). This framework underpins communities of practice (Lave & Wenger, 1991; Wenger, 1998), referred to in this study as CoPs (see Figure 3.1) and provides a lens through which insights into coaching and disciplinary literacy learning can be gained. Figure 3.1 provides as visual summary of the theoretical framework. The following section explains each of the elements, how they are connected, and how they will be used in this study.

Figure 3.1

Theoretical Framework for This Study

Note. Based on *Situated Learning: Legitimate Peripheral Participation*, by J. Lave and E. Wenger, 1991, Cambridge University Press; and *Communities of Practice: Learning, Meaning, and Identity*, by E. Wenger, 1998, Cambridge University Press.

3.1 Social Theory of Learning

A social theory of learning and its elements guided this study. These consist of practice, meaning, identity, and community, and include CoP (Lave & Wenger, 1991; Wenger, 1998). This study explores how coaching influenced secondary mathematics teachers' disciplinary literacy learning and involves developing a richer understanding of the complexities of coaching, disciplinary literacy, efficacy, and the mechanisms that influenced these aspects. In doing so, a social theory of learning (Lave & Wenger, 1991; Wenger, 1998) is foregrounded because of the centrality it places upon the experiences of social processes of practice, meaning, identity, and community (see Figure 3.2). Wenger (1998) states that "a social theory of learning is therefore not exclusively an academic enterprise … it is also relevant to our daily actions, our policies, and the technical, organisational, and educational systems we design" (p. 11). Coaching is a collaborative, social learning process whereby teachers develop meaningful practices and explore their identity within a trusted community. As shown in Figure 3.2, the components of a social theory of learning (Wenger, 1998) provide a useful framework for the research study.

Figure 3.2

Components of a Social Theory of Learning

Note. From *Communities of Practice: Learning, Meaning, and Identity* (p. 5), by E. Wenger, 1998, Cambridge University Press. Copyright 1998 by Cambridge University Press. Reprinted with permission.

The components of a social theory of learning are outlined as follows:

- *meaning*, or participants' learning experiences within the group;
- *practice*, the social activities undertaken by participants;
- *community*, how participants learn to belong to the group – here, mathematics teachers' interactions with colleagues and a coach to explore disciplinary literacies; and
- *identity*, the way participants identify with the discourse, activities, and practices of the learning community to become a member. (Wenger, 1998)

In short, each of these components provides the foundations for a richer understanding of CoPs where a coach and teachers examine the social processes of literacy learning.

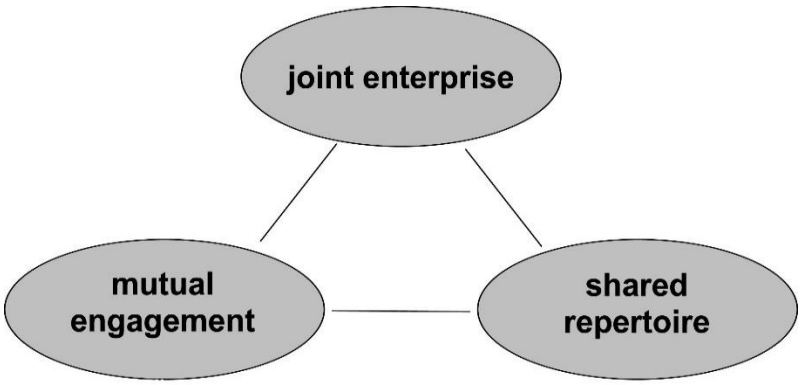
3.2 Communities of Practice

A CoP was foregrounded in the study because of the importance it places on experiences of social processes of collaboration and learning (Lave & Wenger, 1991; Wenger 1998). Lave and Wenger (1991) contend that learning is not an individual pursuit but occurs in a social context. Communities can occur "in any domain of human endeavour", and "learning takes place through our participation in multiple social practices" (Farnsworth et al., 2016, p. 140). A CoP has been described as "a kind of community created over time by the sustained pursuit of a shared enterprise" (Wenger, 1998, p. 45) and "an ongoing collective negotiation of a regime of competence, which is neither static nor fully explicit" (Eckart & Wenger, 2005, p. 583). CoPs are not just a group of people but a "social process of negotiating competence in a domain over time" (Farnsworth et al., 2016, p. 142). In an interview with Etienne Wenger-Trayner, Farnsworth et al. (2016) gleaned insights about the purpose of a social theory of learning, the overarching theoretical framework for this study, as being "to give an account of learning as a socially constituted experience of meaning making" (p. 142).

According to Wenger (1998), three components are intrinsic to collaboration and learning in a CoP: joint enterprise, mutual engagement, and shared repertoire. These components connect to provide structure for social learning in a variety of contexts, including workplaces and education facilities (see Figure 3.3).

Figure 3.3

Dimensions of Practice as the Property of a Community



Note. Adapted from *Communities of Practice: Learning, Meaning, and Identity* (p. 73), by E. Wenger, 1998, Cambridge University Press. Copyright 1998 by Cambridge University Press. Adapted with permission.

Members of a CoP should be heterogeneous (Wenger, 1998), which reflects the nature of multi-age, diverse workplaces. Furthermore, members should be doing something in negotiation with one another, that is, actively engaging. For joint enterprise to exist, negotiation and agreement need to occur so that activities are purposeful and directly related to a shared goal. Wenger-Trayner states that "members of a community of practice may engage in the same practice while working on different tasks in different teams. But they can still work together" (Farnsworth et al., 2016, p. 143). The shared repertoire dimension of a CoP relates to the multitude of resources, tangible and intangible, that result in meaningful actions and outcomes. Further explanation of these three dimensions now follows.

3.2.1 Shared Repertoire: Coaching and CoP

A CoP is a small community of like-minded individuals, in this study, a coach and teachers, who collaborate to achieve a shared goal. Empirical research into mathematics teacher education reveals studies that promote inquiry approaches to learning through a CoP approach (Goos, 2004; Goos & Bennison, 2008). A CoP is appropriate for coaching as according to Goos (2004), key mathematical skills of communication, reasoning, and problem-solving in a secondary classroom are best developed socially. In CoPs, repertoires of knowledge and skills can be shared. Lachance and Confrey's (2003) study of secondary mathematics teachers suggests the

work of PL communities (PLCs), which can also be viewed as CoPs, provides "secondary mathematics teachers with a strong foundation" (p. 113) for reforming mathematics teaching and learning.

According to Brouwer et al. (2012), "communities of practice are groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly" (p. 348). Of particular relevance to the current research project, Brouwer et al. (2012) contend that a CoP "develops a unique perspective" (p. 348) on a topic, which suggests an authentic experience. As well, the researchers offer the view that when teachers expend effort to improve teaching practices in a sustained way, this process also leads to a change in school culture (Brouwer et al., 2012). Butler and Schnellert (2012) purport that CoPs provide teachers with co-regulation; the networking within the learning community provides physical and human resources which support PL.

In the current research project, the teachers and coach developed their CoP together. The RC's secondary teaching and literacy coaching background combined with the four participants' mathematics content knowledge and desire to participate. Contextualised decision-making (Butler & Schnellert, 2012), which uses a blend of disciplinary literacy and instructional coaching approaches, was informed by the collective expertise of CoP members, acknowledging that some teachers had more mathematical content knowledge and disciplinary literacy experience than others. Accordingly, the RC was a participant in the CoP, and knowledge of literacy and coaching practices (as opposed to deep mathematical content) was the RC's contribution. This shared repertoire articulates into the next element of a CoP, which is joint enterprise.

3.2.2 Joint Enterprise: Coaching and CoP

Key to joint enterprise in a CoP is the notion of mutual accountability and interpretation of shared processes and routines. Members of a CoP, for example mathematics teachers, may share both tacit knowledge and explicit routines, processes, and language. Without a CoP, some secondary teachers may keep to themselves. To address concerns of isolationism among secondary teachers (Ciampa & Gallagher, 2016; T. Cox, 2011; Lilly, 2012), schools in different countries, such as Australia, USA, Canada, and Sweden, promote PLC structures. Providing teachers with opportunities to

collectively plan, teach, and observe each other in routine and customised ways is an example of joint enterprise. T. Cox (2011) states that "to overcome isolation teachers must be given time to meet, discuss student work and data", and "be given professional development opportunities that are based upon the direct needs of the students" (p. 4). This example of teacher teams learning together through cyclical meetings to discuss students' learning needs exemplifies joint enterprise.

The key element of identity in Wenger's (1998) social theory of learning is evident in research by Gellert (2013) and Goos and Bennison (2008). It is significant that teachers' identities are heavily influenced by social learning opportunities. "Issues of identity are an integral aspect of a social theory of learning and are thus inseparable from issues of practice, community, and meaning" (Wenger, 1998, p. 145). Gellert's (2013) research investigated early-career elementary teachers (USA: teaching students aged 5–11, similar to primary school in Australia) and their understanding of mathematics. In this study, participants benefited from the CoP approach as teachers "began to think of themselves as mathematics teachers, mainly through their ability to reflect, question, and take ownership of their practice" (p. 113). Goos and Bennison (2008) also studied early-career teachers of mathematics, who had begun participating in an online CoP as pre-service teachers. Throughout their first year of service, participants used bulletin boards and email for regular collegial communication. The research concluded that online communities could evolve much like face-to-face CoPs, as professional discussions and learning were valued by their members.

When teachers collaborate and share, they create social learning opportunities and learn to negotiate, argue, and develop as a PL community. Furthermore, as coaching is becoming more widespread in education, and considered an effective, sustainable PL model for teachers, teaching teams, or CoPs (Lave & Wenger, 1991; Wenger, 1998), it could be viewed as a logical progression for schools to address student literacy (Glasswell, 2012; Griffin et al., 2010; Omidvar & Kislov, 2014). It could be argued that teachers engaged with coaching to build awareness of disciplinary literacies may start to form stronger identities as participants, gradually becoming experienced practitioners.

3.2.3 Mutual Engagement: Coaching and CoP

The third dimension, mutual engagement, refers to the relationships and a sense of community created by participants doing things together in a CoP. For the past two decades, collaborative approaches to address students' literacy standards have been conducted in a range of studies (Brouwer et al., 2012; T. Cox, 2011; Dufour, 2004; Griffin et al., 2010; Lachance & Confrey, 2003; Mistretta, 2012; Rawding, 2013). While each study and site had unique challenges, they also shared similarities. CoP approaches respond to evidence (student data), propose personalised learning approaches, follow a protocol or mutually agreed process, and ideally, time and resources are allocated for teachers to meet within the demands of the workday (Griffin et al., 2010; Rawding, 2013). Small working groups or teacher teams provide the environment for mutual engagement, and have potential for developing tailored responses to problems of practice that allow colleagues to share responsibility and accountability for outcomes. A CoP helps develop professional relationships and build experience, and learning occurs within subject-matter and pedagogical practices (T. Cox, 2011; Dufour, 2004; Griffin et al., 2010; Rawding, 2013).

Dufour's research (2004) is a major influence within educational PLCs, and his three key ideas about the core principle of learning teams reinforce the effectiveness of PL through CoPs. Dufour (2004) asserts that effective PLCs ensure teachers learn, provide a culture of collaboration, and focus on student results from commonly developed formative assessments. Dufour's (2004) principles could be a useful framework for schools to incorporate coaching to tailor unique approaches to collaboration. Underpinning these ideas are inquiry questions, systematic processes, and precise data collection, all practices which align with a coaching approach to PL.

Within a CoP, Dufour (2004) examines the notion of *learning* in contrast to the emphasis on *teaching* as the focus of teachers. His first key idea, "ensuring that students learn" (p. 6) requires teachers to take responsibility for student learning, and the way they do this in PLCs leads to the second key idea, namely, "a culture of collaboration" (p. 8). A systematic (cyclic) approach based on collaboration and deep analysis of student data could create a change in learning culture in some schools. Dufour (2004) cites a range of cases where the PLC approach is business as usual, "the routine work of everyone in the school" (p. 10), with the shared goal of improved student outcomes, or "a focus on results" (p. 10). Dufour (2004) suggests that the

dialogue in schools moves away from the "what" of curriculum and moves towards "how will we know when each student has learned?" (p. 9).

Educational reform has seen a range of different approaches, and the aforementioned methods and ideas to support effective PLCs could be considered timely. Since the research of Showers and Joyce (1996), ongoing PL such as coaching and PLCs is preferred over the one-day style of PD workshop, where motivation is felt by those attending the event but not likely to translate into general practice back at school (Showers & Joyce, 1996). If influencing change on teachers' practice takes time, then a single session or workshop may not have the same potential impact as an ongoing, relational team approach like a CoP (Bean et al., 2010; Dobbs et al., 2017; Ippolito, 2010; Omidvar & Kislov, 2014).

3.2.4 Legitimate Peripheral Participation in a CoP

The literature supports a CoP approach for teachers at all career stages. A component of CoPs is the notion of legitimate peripheral participation, or LPP (Lave & Wenger, 1991), where learners enter a community and gradually take on the identity and practices of the group to become experts. Wenger (2000) likens the early-career teacher to an apprentice, and believes their lack of experience prompts the beginner to seek competence as displayed by the more experienced practitioners. In this context, newcomers are able to interact with the practices of the group, but to a lesser degree and with less responsibility (Lave & Wenger, 1991). Smith (2003, 2009) contends that:

> Initially people have to join communities and learn at the periphery. … As they become more competent they become more involved in the main processes of the particular community. They move from legitimate peripheral participation to into "full participation" (Lave and Wenger 1991: 37). Learning is, thus, not seen as the acquisition of knowledge by individuals so much as a process of *social* participation. ("Legitimate peripheral participation" section, paras. 2, 3)

Participation of more senior teachers in a CoP is valuable as a means of legitimising their competence, taking more responsibility for tasks and contributing to the social learning experience, and bringing new members into the community.

A key consideration for educators is the emphasis on social engagement that can be accessed through a CoP, and the fact that this relational network has the potential, both for teachers in various teams and for students within classrooms, to share identity,

ideas, values, and culture (Omidvar & Kislov, 2014). Social inclusion incorporates aspects of communication, negotiation, and decision-making. Secondary teachers are potentially members of a diverse range of communities, some of which are quite informal. These include communities in a school staff room, faculty, and learning phase, as well as extra-curricular involvement like sports coaching, musicals, or debating teams. Without realising it, teachers may participate in a number of communities where, as newcomers, they develop knowledge and skills and then move to a level of mastery. For example, schools that produce musicals rely on specific teachers at the core (performing arts, visual arts), and new staff to the school may offer to be involved in this project. Through participation in the sociocultural practices of the musical committee, what Lave and Wenger (1991) refer to as situated learning, these novice teachers then become part of the musical CoP. Once a senior teacher moves schools, these once-novice teachers then move into the leadership roles within the particular community (M. Tschannen-Moran & McMaster, 2009).

Within the domain of social learning and LPP, Lave and Wenger (1991) and Wenger (1998) identify states of participation, participation of peripherality, and non-participation of marginality as intertwined. Students have membership in the social learning environment of the classroom; it is there that communication, negotiation, language, and choices about levels of interaction are made (Wenger, 1998). Ewing's (2004) empirical research in mathematics classrooms determined the influence of non-participation on students' mathematical learning. Supportive and inclusive teacher communication within the classroom community significantly influenced students' identity as mathematics learners. Important communication practices and language elements are modelled by the teacher; however, students gradually take on more of the responsibility for their learning, and form their identity as learners, as the practices like collaboration and discourse develop.

3.2.5 Collaboration and Mathematics Teachers

Gellert's (2013) research into CoPs for elementary school teachers revealed the importance of new teachers having access to experienced teachers within an intentionally created mathematical CoP. The gradual increase in knowledge and understanding of mathematical content and pedagogy provided them with more confidence to create a "positive identity for mathematics" (p. 113), improving their

ability to provide quality teaching and learning experiences for students in this key learning area.

Rawding's (2013) research examined the effectiveness of the collaborative learning team for both novice and experienced mathematics teachers, and determined five important factors. These included an organisational structure which closely matched teachers' timetables; flexibility to support the needs of all team members (both early-career and more experienced); shared responsibility as a part of collective expertise; a sense of belonging and enjoyment; and finally, classroom-relevant content (Rawding, 2013). In addition to these insights, Mistretta (2012) researched teacher teams as a way to boost mathematics instruction by a three-step cycle – brief, observe, debrief. Her approach also mixed teachers at varying stages of experience and across grade levels in order to develop classroom instructional practices and content, similar to Lave and Wenger (1991), who acknowledge the importance of experts, or "masters", in the CoP. The inherently social nature of communities, their cyclical processes, and the social engagement of members provide equal opportunity for productive learning whether teachers are newcomers, journey folk, or masters (Lave & Wenger, 1991).

There is a final link between CoPs, coaching, and this research, that is, the perceptions of mathematics teachers. T. Cox (2011) examined teachers' perspectives on building a PL community, and their empirical research findings align with early coaching studies by Showers and Joyce (1996). T. Cox's (2011) research focused on mathematics teachers in a PLC, so it provides valuable insight into what teachers found most beneficial or challenging, and the impact on student behaviours as a result of their professional engagement.

T. Cox (2011) reported that all participants considered PLCs were a more valuable form of PD than one-day workshops, and that their professional knowledge of mathematical content and pedagogy had grown, which in turn positively influenced student results. T. Cox noted that participants identified improved cohesion within the mathematics department, which could positively affect student achievement. In relation to the current study, T. Cox's research provides insight into the potential benefits of a CoP, not only for individual teachers, but also for the combined effect across the department at the proposed research site. The findings from T. Cox's empirical research can also be linked to Showers and Joyce's early work (1996), which identified benefit in collaborative PD approaches. In their study, Showers and Joyce (1996) found that

teaching teams stayed together even after sessions finished. T. Cox's study concluded with suggestions for schools to adopt PLC time within the working week, as a direct link to improved student results. Using coaches and CoPs to support collaboration has considerable potential to become self-perpetuating, as the benefits to teachers and students are widely documented (Bengo, 2016; Ciampa & Gallagher, 2016: Gill et al., 2010; Lilly, 2012; Polly et al., 2013; Sailor & Shanklin, 2010; Showers & Joyce, 1996).

Lave and Wenger (1991) assert that in a learning community there must be a shared domain of interest and engagement with subject matter and pedagogy, for example, the disciplinary literacies of mathematics. The community of teachers must share and interact within the domain, and they should develop resources, solve problems, and learn collaboratively. When included in a CoP, the literacy coach is knowledgeable and competent in literacy practices, while the mathematics teachers could be considered the experts in mathematical subject matter. Learning should occur for all participants, although the literature suggests the presence of "a facilitator or critical other" (Ciampa & Gallagher, 2016, p. 859) may support data analysis. In this project, the RC acted in the role of facilitator (i.e., in focus group interviews), to explore the teachers' perceptions of their learning about mathematical literacies through coaching and collaboration.

3.3 Conclusion

This chapter has described the alignment between coaching, the social theory of learning, and CoPs. It contends that school-based coaching provides an approach to collaboration for secondary mathematics teachers and a coach, whereby participants can co-create new knowledge in a social learning environment. The next chapter presents the study's research design.

Chapter 4: Research Design

Building on a social theory of learning (Lave & Wenger, 1991; Wenger, 1998), previously detailed in Chapter 3, this chapter outlines the exploratory, nested case study design (Thomas, 2011; Yin, 2009, 2012). The theoretical framework supported a case study design to address the following research question: *How can an early-phase coaching program influence secondary mathematics teachers' disciplinary literacy learning?* In support of this overarching question, three interrelated research sub-questions are:

1. *What disciplinary literacies do secondary mathematics teachers draw on when teaching mathematics?*
2. *How can an early-phase coaching program work to strengthen secondary mathematics teachers' disciplinary literacy learning?*
3. *How does an early-phase coaching program contribute to mathematics teachers' disciplinary literacy learning?*

The case study explored the experiences of teachers who participated in a mathematics disciplinary literacy coaching program, facilitated by the RC. It explored the disciplinary literacies which secondary mathematics teachers drew on when teaching mathematics. The answers to the research questions will provide insights about the ways in which coaching influences mathematics teachers' literacy learning, and will inform the implications for coaching, self-efficacy, disciplinary literacies, and strengthening the teaching of mathematics in secondary school.

Chapter 4 is structured as follows. Section 4.1 discusses the methodology of case study and the focus of this research on a particular case – the coaching program. Within this section the purpose and approach to this qualitative study are explained. The possibilities offered by the literature on case study design (Simons 2009; Stake, 1995; Thomas 2011; Yin, 2009, 2012) are explicated prior to establishing the approach adopted for this study. The selection of an exploratory, nested case study is established. Section 4.2 presents an overview of the participants, the secondary mathematics teachers and RC at one school site, purposefully selected to participate as members of a CoP. The coaching program is outlined and discussed in Section 4.3. Data collection instruments are explained in Section 4.4, including focus group interviews, semi-structured

individual interviews, and coach reflective journal. Section 4.5 details the procedure and timeline for the 10-week coaching program involving collaborative learning for all participants, which provides the focus of this exploratory case study. Data analysis is detailed in Section 4.6, including inductive thematic analysis and member-checking processes for ensuring quality. Section 4.7 details ethics and limitations, with reference to the case study approach, and Section 4.8 provides a conclusion.

4.1 Methodology and Research Design

This research project is exploratory in nature, which means it is research building on how a phenomenon occurs. According to Denzin and Lincoln (2008), "qualitative research is a situated activity that locates the observer in the world" (p. 4). Using a case study approach enables the researcher to gain a richly descriptive account of the areas of interest (Denzin & Lincoln, 2000). The project is embedded in education research, which often adopts a case study approach to understand social, educational programs like coaching.

Case study is a methodology frequently used in social science research, as it affords the researcher a unique opportunity to study people and their attitudes, values, behaviours, and beliefs (Neuman, 2003). It emerged during the late 20th century in response to a perceived gap in research methodologies. During the 1960s and 1970s, researchers routinely used more traditional, quantitative methods to determine whether an educational system or program was effective (Simons, 2009). Freebody (2003) notes that early educational researchers were frustrated, as the findings of studies based on laboratory research, experiments, and data were not necessarily applicable to other contexts. Case study is now valued in education research as it provides opportunities for naturalistic data collection through interviews, observations, and document analysis (Angen, 2000), among other methods.

Qualitative social science research highlights the diverse range of case study types that comprise a "case", and that case study research design can be underpinned by philosophically different positions. For example, Robert Stake (1995, 2000) and Robert Yin (2009, 2012), both significant authors in the field of case study design, have contrasting philosophical standpoints. Yin's work defines a case as "a contemporary phenomenon within its real-life context" (2009, p. 13) and contends that researchers should "do qualitative research methodically" (2012, p. 20). Accordingly,

Yin details a systematic emphasis on rigorous data collection and careful and articulated data analysis for case studies. Yin (2009) identifies three types of case studies: *exploratory*, *descriptive*, and *explanatory*. In an exploratory case study, the researcher aims to investigate a process or procedure, whereas in a descriptive approach, the case study is used to describe a particular phenomenon within its context. Explanatory case study affords the researcher the opportunity to explore cause–effect relationships and/or how events happen.

Stake's (1995, 2000) approach is underpinned by a more holistic and constructivist methodology, and his threefold classification consists of *intrinsic*, when the researcher has an interest in the case; *instrumental*, when the case is used to understand more than what is obvious to the observer; and *collective*, whereby a group of cases is studied.

Helen Simons (2009) argues for case study research as a way of revealing more contextual information and deeper understandings of the complexity of educational practices regardless of the methods employed; however, she agrees with Stake (1995, 2000) that no matter the methodology, what really "defines a case is its singularity – of the phenomenon being studied" (Simons, 2009, p. 20).

The impetus in this research to explore or find out more about coaching aligns with Thomas's (2011) adaptation of Yin's (2009) focus on an exploratory case study from his typology, the purpose of which is to reveal insights into a problem or issue. In this study, Yin's (2009) focus on an embedded case is used as an empirical form of inquiry into the coaching program as it enables the identification of sub-units within the case (the four participating teachers), which in turn, allows for a more detailed level of inquiry where the goal is to describe the features, context, and process of a phenomenon. Accordingly, an exploratory case study design (Thomas, 2011) is adopted in this study in order to understand the teachers' experiences within a coaching program focused on mathematics disciplinary literacy learning.

It must be noted that rather than using Yin's (2009) terminology, Thomas (2011) employs the term *nested* instead of *embedded* to describe "nested units within one case" (p. 153). He contends that

> "nested" gives more of a sense of a subunit *fitting in* with a larger unit, rather than it being *implanted* there. It is that *fitting in* in which you are interested – how does the subunit connect with the other subunits and the whole? (Thomas, 2011, p. 152)

The reason for conducting a nested study is to contrast the sub-units (for example, mathematics teachers and their experiences in the community of practice) as part of the case – the coaching program in the school. Figure 4.1 provides a visual representation of this exploratory nested case study approach.

Figure 4.1

Nested Case Study

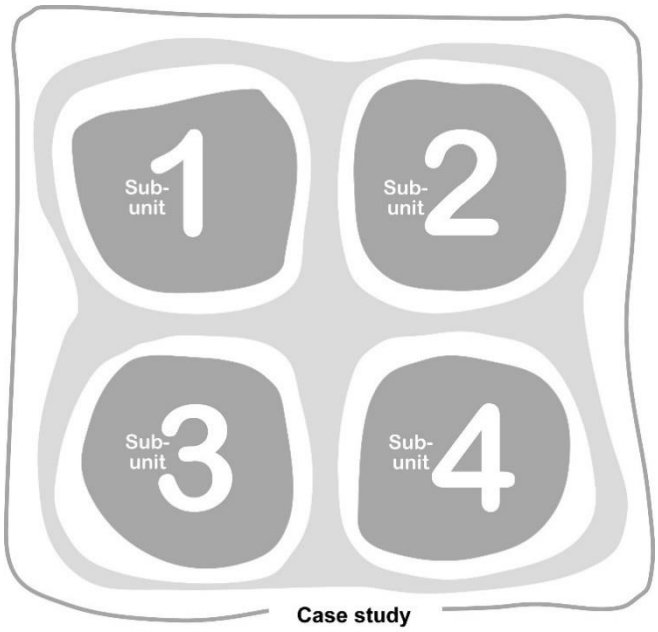


Figure 4.1 depicts the structure of this case, including the case boundary, or single outline, representing the bounded nature of the case; the four teacher participants are the sub-units. The shading behind each sub-unit symbolises the presence of the RC, who is situated within the boundary, studying from within (Thomas, 2011). The next section discusses the participants.

4.2 Participants

The participants in this case study research were the RC and four secondary mathematics teachers. Participants were purposively sampled, that is, directly approached by the RC. Purposive sampling, or the deliberate selection of participants, was used to maximise outcomes in this case study (Creswell, 2014). Neuman (2003) states there are three situations where purposive sampling is justified: a unique, informative case; research into a specialised population; and when the researcher

wants to gain deep understanding of a case. Thomas (2011) argues that case study research does not follow other methods of more equitable or random participant sampling; "there is no expectation that this case is representative of the population. It's a choice, a selection" (p. 62). For accessibility, participants were selected from the mathematics faculty at Reservoir State High School using homogeneous sampling, which is the deliberate selection of particular people from a subgroup. The four participants and the RC comprised a CoP, where the mutual engagement, shared repertoire, and joint enterprise (Lave & Wenger, 1991; Wenger, 1998, 2000) were coaching and collaboration to support disciplinary literacy learning.

A key reason for purposive sampling was to focus on mathematics teachers' experiences for data collection. The four participants were Sally (P1), Harry (P2), George (P3), and Pete (P4) (pseudonyms), who taught mathematics across junior secondary (Years 7, 8, 9) and senior secondary (Years 10, 11, 12). Based on their timetables, participants nominated their preferred year level to engage with in the study. Of the four teachers, Sally was the only participant with coaching experience, having volunteered to participate in a small coaching trial at Reservoir State High School the previous year. Sally had taught for 6 years and worked at the research site for 4 years, teaching mainly mathematics and science in the junior secondary phase. The other three teachers, Harry, George, and Pete, each had over 15 years of teaching experience and taught mathematics across both junior and senior secondary phases. Harry originally taught as a primary school teacher, transitioning to secondary school in 2015 when Queensland Year 7 students were moved from primary to secondary school. George was the newest arrival to Reservoir State High School (apart from the RC in 2020); he was recruited to develop the school's pedagogical framework in 2018. Pete had been at Reservoir State High for 8 years, teaching mathematics and science predominantly in senior classes (Year 11 and Year 12). Note that Harry (P2) and Pete (P4) completed a degree course which offered the option of majoring in either Sport Sciences or Education; they chose Education and were able to apply for accreditation with the Queensland College of Teachers upon completion of the degree. As the RC held a substantive leadership position at the school, that of a deputy principal, it was critical that RC emphasised her collegial role with the participants in order to mitigate against any potential power imbalance during their collaboration. Accordingly, in her

discussions with participants prior to data collection, the RC reiterated her role as a RC and colleague in the CoP. Table 4.1 provides a summary of the participants.

Table 4.1

Summary of Participants

Participant	Qualifications	Teaching experience	Previous coaching experience	Year level taught in the study
P1 Sally	Bachelor of Business Management; Graduate Diploma of Education (Biology & Business Management)	6 years	Yes	7 Mathematics
P2 Harry	Bachelor of Applied Science (Human Movement Studies)	15 years	No	8 Mathematics
P3 George	Bachelor of Science (Microbiology & Biomedical Science); Bachelor of Education (Secondary)	16 years	No	8 Mathematics
P4 Pete	Bachelor of Applied Science (Human Movement Studies)	18 years	No	12 Essential Mathematics
RC	Bachelor of Human Movement Studies (Education)	31 years	Yes	NA

Teachers with different levels of experience provided the CoP with a range of members at varying career stages. As previously noted in Chapter 2, research into CoP for teachers at different career stages is beneficial for both new teachers (with mentoring and access to experts) and experienced teachers in showing mastery and modelling good practice (Gellert, 2013; Lave & Wenger, 1991; Rawding, 2013). The participants remained involved for the duration of the project; however, due to constraints and challenges with participants' roles, some teachers were observed more than others. Sally and Pete were observed three times, and George and Harry were observed twice within the 4 weeks of observations.

4.3 The Coaching Program

4.3.1 Background to the Coaching Program

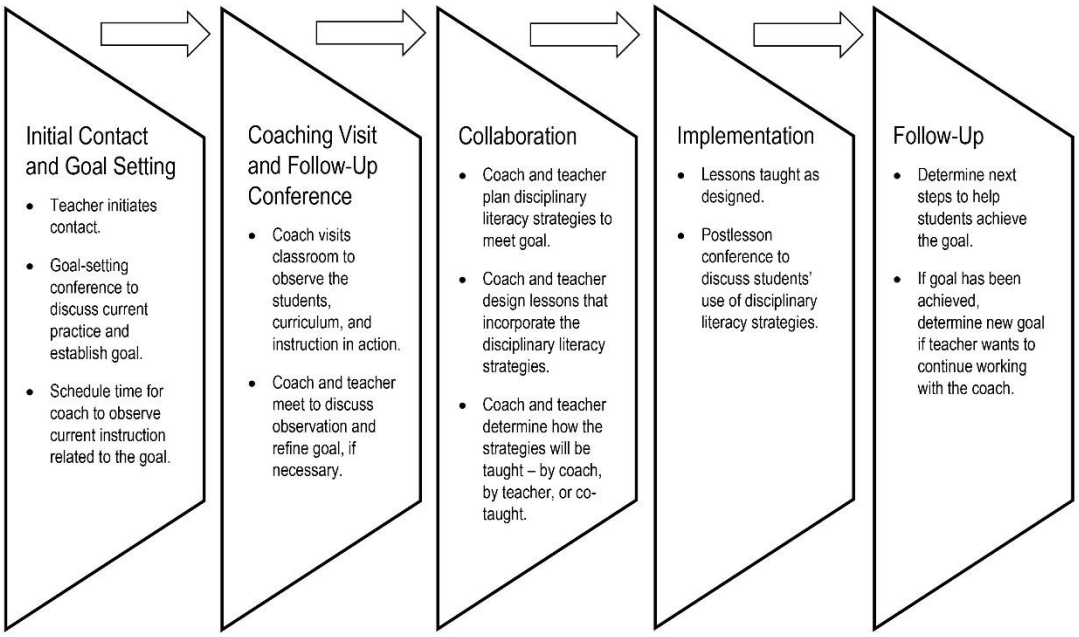
This section explains the foundation of Reservoir State High School's coaching program as informed by instructional coaching (Knight, 2009, 2010) and disciplinary literacy coaching models (Dobbs et al., 2017; Elish-Piper et al., 2016). As stated previously in Section 2.2.1, this study was designed to incorporate elements of Knight's (2009, 2010) partnership approach, as well as the collaborative processes of disciplinary literacy coaching, where the RC and teachers interact individually or in groups as a CoP.

Knight (2009, 2010) developed instructional coaching and the notion of an instructional coach to provide an alternative form of teacher PD from "one-shot programs" (p. 2). According to Knight (2009), instructional coaches anchor their coaching in research-based, scientific practices, use their relational communication skills to collaborate with teachers, and select and apply instructional strategies. As previously noted, Knight's (2009) partnership approach is a philosophy based on the principles of equality, choice, voice, dialogue, reflection, praxis, and reciprocity. By applying these aspects to the coaching program, the experiences and practices of participating teachers and the RC created a mutually respectful and enriching learning environment.

Disciplinary literacy coaching has developed from literacy coaching, and focuses on improving teacher instructional capacity related to disciplinary literacies (Elish-Piper et al., 2016). Dobbs et al. (2017) state that disciplinary literacy coaches can apply three stances – facilitating, collaborating, and consulting – and contend that "coaches typically shift from one stance to another within a single coaching conversation" (p. 20). Elish-Piper et al. (2016) discuss a range of coaching models, which include the teacher-initiated model, the co-teaching model, the department/team model, and the liaison model. The coaching program devised for this research is closely aligned with the teacher-initiated model. According to Elish-Piper et al. (2016), the teacher-initiated model follows a progression: initial goal setting; coaching visits (or observations in the classroom) with follow-up conferencing; collaboration between teacher and coach to determine appropriate strategies and lesson design; further implementation of strategies by the teacher in lessons; and finally, follow-up discussion to determine the success of the goal (see Figure 4.2.

Figure 4.2

The Teacher-Initiated Model



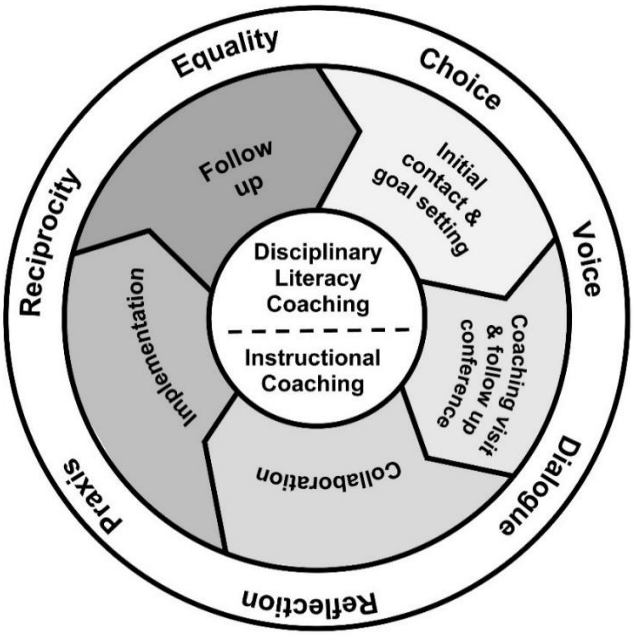
Note. From *Collaborative Coaching for Disciplinary Literacy: Strategies to Support Teachers in Grades 6–12* (p. 27), by L. Elish-Piper, S. K. L'Allier, M. Manderino, and P. Di Domenico, 2016, Guildford Publications. Copyright 2016 by Guildford Publications. Reprinted with permission.

In summary, the proposed coaching program is broadly informed by instructional coaching's partnership principles (Knight, 2009), with additional disciplinary literacy structures, and the teacher-initiated model (Elish-Piper et al., 2016, p. 27). During the course of the observation/conversation coaching cycle, the RC shifted between facilitating, collaborating, and consulting (Dobbs et al., 2017). When conducting coaching conversations, alternating between facilitating and collaborating is not overt; rather, it is a response based on the coachee's needs. For example, the teacher may reflect on an aspect of the lesson and wonder about a way of addressing this. The RC could use prompting and cueing questions to enable the teacher to follow a line of inquiry, such as, *Who else does this well? What could you do? What would that look like? What else?* Or, if the teacher needed more support, as a consultant, the RC could say, "Are you interested in some ideas from me?" Elish-Piper et al. (2016) have identified eight guidelines for effective disciplinary literacy coaching (see Appendix A). It is important to consider guideline number five, that is, that the disciplinary literacy coach should not be an expert in every discipline, but is a collaborator. In this study, the RC is not a trained mathematics teacher, but is an

experienced secondary school teacher, as well as a trained literacy coach. Figure 4.3 shows the coaching program as informed by the partnership principles (Knight, 2009) and Elish-Piper et al.'s (2016) teacher-initiated coaching model.

Figure 4.3

The Coaching Program



Note. Adapted from *Instructional Coaching: A Partnership Approach to Improving Instruction*, by J. Knight, 2009, Hawker Brownlow Education; and *Collaborative Coaching for Disciplinary Literacy: Strategies to Support Teachers in Grades 6–12,* by L. Elish-Piper, S. K. L'Allier, M. Manderino, and P. Di Domenico, 2016, Guildford Publications. Adapted with permission.

4.3.2 The Coaching Program

The coaching program consisted of a cyclical partnership over 10 weeks between teachers and the RC. Individual interviews, which were considered to be the initial coaching conversation, were conducted with each participant after the first focus group. The purpose of this timing was to provide the teachers with an opportunity to reflect on the disciplinary literacy materials shared in the first focus group and to think about their potential goal. The coaching cycle started with an initial coaching conversation between each teacher and the RC, culminating in a specific, measurable, achievable, realistic, and time-bound (SMART) improvement goal (Doran, 1981) directly related to student learning. Following this, the cycle followed a pattern of lesson observations over the next 4 weeks. Teachers planned and taught their lessons,

incorporating disciplinary literacy aspects based on their SMART goals (see Appendix B). Observations took 70 minutes and post-observation coaching conversations were approximately 15 minutes, with the observations recorded in note form by the RC on a lesson observation template (see Appendix C). The template was devised by the RC to capture notes, thoughts and wonderings, and question prompts to guide the post-observation conversation.

The overall goals of the coaching conversation were to prompt the teacher to reflect and to provide feedback about the disciplinary literacy aspects of the lesson. The conversation was a strategy to support the development of smaller learning targets (for example, new strategies or skills) which could be incorporated into future lessons. Throughout the coaching program, teachers contacted the RC, either in person or via email, to communicate any changes to the schedule or to seek further support in the form of resources. At the conclusion of the coaching cycle, teachers reflected on their goal with the RC.

4.3.3 Coaching Observation and Reflections

The observation template (Appendix C) supported the RC and teacher to focus each classroom visit on key observable processes related to disciplinary literacy instruction. These observations formed the basis for discussion to help the teacher further refine their goal. As a consideration to the participating teachers, post-observation discussions were timely, occurring immediately after the lesson, and allowed collaboration between the RC and teacher to determine future lessons. Further implementation of the disciplinary literacy strategies occurred in the following teaching/observation cycle.

4.4 Data Collection

This section details the methods used to collect relevant research data, namely semi-structured focus groups, semi-structured individual interviews, and the RC's reflective journal. Table 4.2 outlines the RC activities across the 10-week coaching program, together with the data collection instruments and the related research sub-questions.

Table 4.2

Researcher/Coach Activity, Data Collection Instruments, and Research Questions

Week	Coach's role	Researcher's role	Data collection instrument and sub-question (SQ) focus
1	Prepare coaching and mathematics disciplinary literacy stimulus materials to facilitate focus group: • journal articles • disciplinary literacy strategies.	Facilitate initial semi-structured focus group interview with four participants: • audio recorded • notes taken by researcher. Focus group questions: • *What type of reading, writing, and thinking is most valued in maths?* • *What special content knowledge and skills are needed to be a successful maths teacher?* • *Could you describe/share a type of activity you already do to support mathematical reading, writing, or thinking?* • *What do you already know about a coaching approach in schools?* • *Are you interested in working with a coach to develop your knowledge and understanding of disciplinary literacy in mathematics?* • *Are you interested in collaborating with colleagues, sharing your experiences, and furthering your knowledge and skills to support teaching and learning in mathematics?*	Instrument #1: Initial semi-structured focus group. SQ1: *What disciplinary literacies do secondary mathematics teachers draw on when teaching mathematics?*

Week	Coach's role	Researcher's role	Data collection instrument and sub-question (SQ) focus
2	Initial meeting to facilitate SMART goal setting: • Meet with each teacher separately in one-on-one meetings. • During the meeting, the main aim is to establish a SMART goal with a focus on mathematical disciplinary literacy strategies. • Teacher and coach draw on information from journal articles and discussion from the focus group in Week 1.	Conduct initial individual semi-structured interviews: • audio recorded • note taking by researcher • critical reflection. Individual interview questions: • *After everything we've talked about so far, what disciplinary literacy approach do you want to develop through coaching?* • *What could that look like in your classroom?* • *What is currently happening? What would change?* • *What will you do? When will you start?* • *What do you need from me?*	Instrument #2: Initial individual semi-structured interviews. SQ1: *What disciplinary literacies do secondary mathematics teachers draw on when teaching mathematics?* Instrument #3: Researcher/coach's reflective journal. SQ2: *How can an early-phase coaching program work to strengthen secondary mathematics teachers' disciplinary literacy learning?*

3–9	Classroom observations and follow-up conference; collaboration; implementation:
	• Observe one lesson/week with teachers:
	  ○ take observation notes
	  ○ conduct 10–15 minute post-lesson conference.
	• Ongoing collaboration and consultation with teachers related to SMART goal progress and supporting resources:
	  ○ emails; resources
	  ○ conversations
	  ○ model lessons; co-teaching
		Complete researcher/coach's reflective journal:
		• anecdotal observations and reflections
		• identify emerging themes in the data.
			Instrument #3: Researcher/coach's reflective journal.
			SQ2: *How can an early-phase coaching program work to strengthen secondary mathematics teachers' disciplinary literacy learning?*

Week	Coach's role	Researcher's role	Data collection instrument and sub-question (SQ) focus
	Potential follow-up conversation prompts: • *How did this session/activity/lesson go?* • *What went well? What else?* • *What would you change? Why?* • *What would that look like?* • *What will you do next week?* • *Do you need anything from me?*		
10		Schedule focus group – Zoom. Facilitate final semi-structured focus group with four participants: • discussion and reflection • critical analysis • refine themes • audio recorded (Zoom) • note taking by researcher. Focus group questions: • *What aspects of this coaching program contributed most to disciplinary literacy learning?* • *What are the least useful aspects of coaching for disciplinary literacy learning?* • *What changed in your teaching and learning as a result of coaching?* • *Would you consider accessing coaching for future professional development? (Why?)*	Instrument #1: Final semi-structured focus group. SQ2: *How can an early-phase coaching program work to strengthen secondary mathematics teachers' disciplinary literacy learning?* SQ3: *How does an early-phase coaching program contribute to mathematics teachers' disciplinary literacy learning?*

Week	Coach's role	Researcher's role	Data collection instrument and sub-question (SQ) focus
		• *How could you share your learning about disciplinary literacy with colleagues? What could you do? When would you do it?* • *What would change in your faculty as a result of collaborative practices like coaching? Could this transfer to other areas of the school?*	
10	Follow-up – meet via Zoom with teachers individually to review/reflect on their SMART goal. Focus of meeting: • celebrate successes/goals • discuss what worked and what didn't • next steps for student achievement. This section of the coaching program aligns with the research program.	Conduct individual semi-structured interviews: • audio recorded (Zoom) • note taking by researcher. Individual interview questions: • *How has participation in the coaching program strengthened your disciplinary literacy learning in mathematics?* • *What teaching practices, if any, will you sustain as a result of coaching in disciplinary literacies?* • *Would you engage with coaching as a method of professional development in the future?* • *What other professional development formats could be more effective to develop disciplinary literacy learning?*	Instrument #2: Final individual semi-structured interviews. SQ2: *How can an early-phase coaching program work to strengthen secondary mathematics teachers' disciplinary literacy learning?* SQ3: *How does an early-phase coaching program contribute to mathematics teachers' disciplinary literacy learning?*

4.4.1 Focus Group Interviews

Focus groups were devised in response to marketing campaigns in the mid-20th century, as a way of gathering research about new products (Flores & Alonso, 1995; Minichiello et al., 1995). More recently, focus groups have become a common method for qualitative research, as this style of group interview is a flexible approach that encourages discussion and may reveal participants' perceptions and values (Nyumba et al., 2018).

Flores and Alonso (1995) assert that "focus groups are an important way of discovering what interviewees think about a concrete theme – what feelings, attitudes, reactions, and doubts they have concerning it – in a situation in which they can contrast their opinions" (p. 84). According to Nyumba et al. (2018), there are a number of sub-categories within the focus group type, including two-way, duelling moderator, mini, and online focus groups (p. 24). The type of approach most suited to this project is the single focus group, most commonly used in qualitative research across such disciplines as academic social science, conservation research, sociology, psychology, and education (Nyumba et al., 2018). The single focus group is an interactive discussion between participants and a moderator or facilitator, held face-to-face, in one place.

In this study, two semi-structured focus group interviews were conducted: an initial one at the commencement of the research cycle and a final one at the conclusion of the project. These focus groups were of one-hour duration, held on-site at the school (note the final focus group was conducted via Zoom), and audio recorded for later transcription. A professional transcriber was engaged to manage the transcription process. The RC took anecdotal notes throughout the interview process to cross-check what was heard. Focus group interviews provide participants with an opportunity to socially interact with each other and discuss topics related to the research question (Minichiello et al., 1995).

4.4.2 Semi-Structured Individual Interviews

Minichiello et al. (1995) state that in semi-structured interviews, researchers use "the broad topic in which they are interested to guide the interview" (p. 65). This style of interview schedule uses a list of topics as a guide, without the constraints of a fixed sequence of specific questions, as it allows each participant to engage and share

insights and perceptions in a flexible way. This approach to interviewing was suitable for the research project as it provided both the RC and the teacher participants with an opportunity for in-depth discussion into those aspects of disciplinary literacy and coaching that were directly related to them. The RC was afforded insight and greater understanding of each participant's experiences as a result of individual interviews.

The RC individually interviewed each participant twice during the research cycle: once at the beginning (after the focus group interview) and once at the end of the project, after the final focus group interview. As George (P3) was unavailable for the first focus group session, his first interview was longer and included questions arising from discussions in the focus group. Coaching began with the individual interview at the beginning of the project to provide each teacher with an opportunity to clarify any questions arising from the focus group, set a SMART goal (Doran, 1981) for the coaching cycle, further discuss ideas and strategies, and plan a suitable observation schedule. The boundaries of the coaching relationship and the duality of roles undertaken by the RC were established at this interview. It was important to clarify and separate the coaching role from that of the researcher to ensure the validity of the research (Creswell, 2014). At the conclusion of the project, a final individual interview allowed participants an opportunity for personal reflection on the process. Each individual interview took 30 to 40 minutes via Zoom.

4.4.3 Coach Reflective Journal

The RC kept a reflective journal to record observations, interactions, and critical reflection leading to the RC's own learning about disciplinary literacies and processes throughout the project. Insights gained from the weekly observations and discussions provided data and potential themes or patterns for further analysis. The reflective journal was also used to record memos and visual diagrams such as mind maps to support the process (Saldaña, 2009).

4.5 Procedure and Timeline

Ethical clearance was received from the Queensland University of Technology (QUT) and the Queensland Education Research Inventory (QERI), the government body responsible for educational research in Queensland state schools (see Section 4.7). Once QERI confirmed that the methodology aligned with the DoE's research guidelines,

permission was sought and granted directly from the principal of Reservoir State High School. Data collection was ongoing throughout the 10-week project, which occurred within one discrete Queensland school term, Term 1 (January–March) in 2021. Table 4.3 outlines the steps in this procedure and the timeline, with milestones.

Table 4.3

Procedure and Timeline for Research

Phase	Activity
Prior to study	Seek in-principle approval from site principal. Directly approach potential participants; distribute information and schedule for coaching program and research project as purposive sampling invitations. Provide to participants: • project summary and overview • participant information statements and consent forms (1 week return of consent).
January–March 2021	
Week 1	Semi-structured focus group interview (all participants; recorded; member checking)
Week 2	Semi-structured individual participant interviews (recorded; member checking)
Weeks 3–9	1 x weekly classroom observation and post-observation coaching discussion per participant (not recorded; total of four individual observations per week) Coach completes reflective journal
Week 10	Focus group interview (all participants; recorded; member checking) Individual participant coaching interviews (recorded; member checking)
Post study (12 months)	Collate data; analyse data (thematic analysis); interpret data Collate findings; present report

4.6 Data Analysis

4.6.1 Thematic Analysis

For the purpose of this study, thematic analysis is defined as a method that invites interpretation by the researcher, as researcher judgement is a critical part of data analysis (Braun & Clarke, 2006). Braun and Clarke (2006) state that thematic analysis is "a method for identifying, analysing and reporting patterns (themes) within data" (p. 6). It is an active process, that is, the researcher actively identifies themes; they do not passively "emerge" from data sources. Thematic analysis includes identifying

themes that represent patterns, and recognising when a theme is key in relation to the case. According to Minichiello et al. (1995), useful analysis elements for coding transcripts include identifying key words, concepts, sentences, and themes.

Saldaña (2009) explains the process of coding as a heuristic or "exploratory problem-solving technique without specific formulas to follow" (p. 19). A theme is the outcome of the coding process, not an actual code. There are no fixed rules about how often or how many times a theme appears in the data; more important is whether the theme is significant in relation to the research question (Saldaña, 2009).

Braun and Clarke (2006) argue that "researcher judgement is necessary to determine what a theme is" (p. 10). Minichiello et al. (1995) reinforce the importance of researcher expertise to identify "key issues and peripheral issues" (p. 253) and whether or not to apply researcher knowledge to interpret the transcripts, as this may lead to misunderstandings. Braun and Clarke explain approaches related to decisions about how, and at what level, themes are to be identified and analysed in the data. For example, in their explanation of the semantic or explicit level of theme analysis, recognition of themes begins at a descriptive level; the researcher, using theoretical approaches from the literature, then interprets the data.

Well-defined themes can provide clarity and structure to the process of analysis. According to Braun and Clarke (2006), there are six phases of thematic analysis, although the researchers point out that within qualitative research, the steps are more guidelines than rules, and researchers work recursively rather than in a linear way. The phases begin with the researcher familiarising themselves with the data, then transcribing any verbal data to generate initial codes. Within these codes, the researcher searches for themes, then refines and reviews them so that a clear definition is given. "By 'define and refine' we mean identifying the 'essence' of what each theme is about" (Braun & Clarke, 2006, p. 22). Once the themes are defined and named, the researcher will identify sub-themes, which can "be useful for giving structure to a particularly large and complex theme" (p. 23). The final step is to produce the finished report. This is a way for the researcher to tell the story of the research and provide the reader with a well-sequenced and logical account. The researcher's task is to provide a narrative which justifies the importance of the research, not just providing data, but a credible argument supported by evidence (Braun & Clarke, 2006).

In this project, data analysis incorporated a collection of observation discussions between the teacher and RC, focus group discussions, and individual interview data. Rigorous conversations with the supervisory team helped to inform the final themes in the study. The RC's reflective journal provided insight and reflection to support themes and sub-themes in the data. The theoretical framework for this study provided an opportunity for rich analysis, to gain an understanding of the ways in which school-based coaching fosters disciplinary literacy learning for secondary mathematics teachers. Saldaña (2009) states that the number of codes and categories will vary according to how detailed the researcher wants the analysis to be. In this study, the initial categories began as broad topics; for example, two predominant categories were *mathematical literacy* and *teacher efficacy*. Once category two, teacher efficacy, expanded to 32 individual themes, the RC started to analyse and group sub-categories. Saldaña (2009) colloquially calls this grouping "lumping", whereas the opposite process is "splitting" to create finer, more nuanced themes. Grouping was necessary to better manage the number of sub-categories and to provide themes which reflected teachers' actions and conversation with the RC. For example, teacher efficacy comprised the following sub-categories: *uses instructional practices*, *has an experimental mindset*, *collaborative and collegial*, and *self-reflective and responsive to student learning gaps*.

4.6.2 Triangulating Data

Qualitative researchers use processes such as triangulation and member checking to ensure accuracy and credibility (Creswell, 2014; Yin, 2009, 2012). Triangulation, or the notion that "viewing from several points is better than viewing from one" (Thomas, 2011, p. 68) is achieved by using a range of data sources; in this research project the data sources were focus groups, individual interviews, and the RC's reflective journal entries.

Validating the accuracy of results and interpretations is important in qualitative research. Along with triangulation, member checking – the process of reviewing findings with participants to verify the accuracy of accounts – should provide the researcher with trustworthy data (Creswell, 2014; Minichiello et al., 1995). Member checking was routinely observed after each focus group and individual interview was conducted. The RC sent digital copies of the transcripts via email to each participant

for member checking. Each participant was given the opportunity to read and reflect on the transcript to ensure it accurately reflected their discussion and contributions. All participants were satisfied with the transcripts as provided.

4.7 Ethics and Limitations

This study was conducted in accordance with the guidelines and protocols of the *National Statement on Ethical Conduct in Human Research (2007) – Updated 2018* (National Health and Medical Research Council, 2018). The research study adhered to the QUT research ethics guidelines and was approved by the QUT Office of Research Ethics and Integrity with ethics approval number 1900001151. This research involved adult participants and was considered minimal risk, as the potential for exploitation due to age, gender, socio-economic status, and level of education of the teachers was low. Following QUT approval, a second application for ethical approval was submitted to QERI, the government body responsible for educational research in Queensland state schools. Once granted, the principal at Reservoir State High School granted official departmental permission to conduct research at the school for 10 weeks during Term 1, 2021.

Participants' informed consent was sought in writing, indicating their participation was voluntary and ensuring open and transparent communication about the purpose, duration, and methods of the study (see Appendix D). Focus groups, individual interviews, observations, and discussions were scheduled at a time and location most convenient for participants. Observations and post-observation discussions took place with minimal extra impact on teachers' workloads. The post-observation discussions were short (15 minutes or less) to minimise interruption. The RC provided clear initial written communication about organisational matters and was in contact in person or via email throughout the coaching program when required. Due to the impact of the COVID-19 pandemic during 2021, the final focus group and individual interviews were held via Zoom.

4.7.1 Benefits and Risks for Participants

The benefits for participants as a result of involvement in this project included time to collaborate with a disciplinary literacy coach, and opportunities to collegially

engage and share experiences. Participants received individual PL to inform their knowledge and understanding of disciplinary literacies.

Thomas (2011) notes that "it's especially important to consider ethics in case study research since you may be very closely involved with the research participants" (p. 68) and that case study participants could be at risk of embarrassment and exposure if data containing their personal views were treated with indiscretion. To ensure transparency, the RC discussed all aspects of the project and purposes for research so that participants could agree to them in advance. Minichiello et al. (1995) argue that confidentiality involves more than names of participants; it also includes protecting other information which could reveal participants' identities. Despite using pseudonyms, maintaining accurate, discrete participant information, and storing digital files and personal research notes securely, it is possible that the anonymity of the teachers may not be preserved. This is because the study site is a relatively small community of teachers, and it is likely other staff may recognise the participants from the research data. Ongoing member-checking processes and an option to leave the study provided participants with reassurance; however, when all four teachers emailed to confirm the transcripts were accurate, they expressed satisfaction with their level of involvement and were not concerned about being identified as a participant in the research project.

4.7.2 Benefits and Risks for the RC

While the research was designed with consideration for qualitative research protocols, this section acknowledges the role of the RC as a participant and facilitator within the study. Of particular significance to this study is Simons' (2009) focus on the importance of the researcher in the roles of gathering, interpreting, and reporting data, and the rigour required to faithfully shape and interpret the case. The RC's own values and attitudes played a part in this project, as the researcher was also the disciplinary literacy coach – there was an opportunity to "learn about yourself" (Simons, 2009, p. 4).

Researcher subjectivity is an essential factor to consider, as being an integral player in the CoP and a co-creator of socially constructed learning, the RC's background and experiences were subjective. The rationale for undertaking this project in the first place was not a "neutral, objective, value-free choice" (Minichiello et al., 1995, p. 179). As the researcher in the role of interviewer, the RC could be unconsciously influenced by subjectivity in unintended ways, including cultural

perceptions, ethnicity, age, or gender (Minichiello et al., 1995). As noted, the RC was mindful that her substantive leadership position at the school could also have negatively influenced participants' perceptions, given the potential power imbalance. Prior to data collection, the RC reiterated her role as colleague, a researcher and a coach with the participants. The RC's dual role in the study was also openly discussed and reiterated with participants during the first focus group and interviews. The RC acknowledges a bias towards a coaching approach and recognises that it may have influenced perspectives when analysing and interpreting teachers' responses in conversations. To mitigate potential bias, the RC followed qualitative research design protocols with a particular focus on validity and reactivity (Maxwell, 2013). Reactivity, or the effect of the researcher on the individuals studied, was mitigated by structuring research questions and sub-questions to remove assumptions.

The idea that both participants and interviewers can manipulate or influence the research is explored by Minichiello et al. (1995); they posit that by half-answering questions or providing misleading answers, the teachers could also distort findings. To mitigate the potential effects of researcher subjectivity, the RC's status and purpose for the project were foregrounded with the participants. As well, to minimise any potential manipulation effect by participants, cross-checking and opportunities for the RC to clarify the teachers' answers were built into the process.

The insider-outsider controversy (Minichiello et al., 1995) in research refers to a question of who should carry out specific research, that is, someone from within the group or an outsider. For this project, as an educator and a coach, the RC identified as an insider. Years of teaching experience, coaching training, and insight into the teaching context could be considered an advantage and non-threatening to other participants. Conversely, the RC could also be regarded by the participants as an outsider in the CoP, which consisted mainly of mathematics teachers and their shared knowledge and experience of mathematics content. Additionally, the awareness that a school leader (not just a disciplinary literacy coach) was present in the classroom could reinforce the outsider perception. There is an argument that an insider could show subjectivity in data collection; however, the RC's experience in coaching, work history, and insider status provided better "access to the field" (Minichiello et al., 1995, p. 183) than that of a complete outsider.

4.7.3 Limitations

The qualitative case study in this research has some limitations. Given its subjective nature, the findings are not necessarily able to be generalised to other educational settings. Another limitation is the sample size of four participants; indeed, a larger sample of teachers across a wider spread of content areas may have revealed more insights that would provide educators with the impetus to introduce a coaching program in the future. However, due to the nature of qualitative research, a larger sample would be extremely time-intensive (Minichiello et al., 1995). Parallels may be drawn, however, between the findings of this study and the broader benefits of a disciplinary literacy coaching approach for schools experiencing staff constraints or with teachers in out-of-field teaching areas.

The four teachers recognised the potential benefits of an embedded coaching approach to their disciplinary literacy learning; however, due to the dynamic nature of teaching and learning, the number of coaching observations varied for each participant. One factor influencing the number of observations was the RC's main role and duties in the school as a deputy principal. Other factors included personal factors, work demands, and participants' schedules. To compensate for this, the RC invited participants to share their reflections via email as well as in person. This further supported collegial engagement through coaching.

4.8 Conclusion

This chapter has established the design and purpose of a nested case study research project to explore how coaching influences secondary mathematics teachers' literacy learning. The work of Thomas (2011) and Yin (2009) provided a structure for this exploratory case study. Over the course of one school term (10 weeks), four participants participated in a coaching program by collaborating with a literacy coach to develop disciplinary literacy awareness. Focus groups provided data to inform the coaching program and provided valuable insight for the RC to support the literacy learning of participants in a CoP. Individual interviews and classroom observations as part of a coaching program allowed the RC and teachers to identify, discuss, and reflect on coaching and how it supports classroom practices related to the disciplinary literacies of mathematics. The next chapter presents findings and discussion in relation to research sub-question one.

Chapter 5: Findings and Discussion – Research Sub-Question 1

The previous chapter presented the methodology and research design for this investigation into a school-based coaching program as guided by the main research question: *How can an early-phase coaching program influence secondary mathematics teachers' disciplinary literacy learning?* It provided the foundation for addressing the sub-questions and acknowledged the importance of a qualitative case study approach for investigating coaching. As detailed in Chapter 3, a social theory of learning (Lave & Wenger, 1991; Wenger, 1998) provided the theoretical framework through a CoP lens.

Chapters 5, 6, and 7 present the findings and discussion of data gathered from the four participating secondary mathematics teachers, Sally (P1), Harry (P2), George (P3), and Pete (P4), and me as RC during the 10-week coaching program at Reservoir State High School. As this research was concerned with the introductory phase of collaborative PL during the early-phase coaching program, and the participants had varying degrees of experience and mathematical knowledge, it was anticipated that the conversations about the disciplinary literacy of mathematics would be at a developmental level.

The findings and discussion are presented as follows: sub-question one is addressed in Chapter 5, sub-question two is addressed in Chapter 6, and sub-question three is addressed in Chapter 7. For clarity, the initial presentation of sub-questions and themes is predominantly outlined in Chapter 5 and reiterated briefly in Chapters 6 and 7.

The three sub-questions are as follows:

1. *What disciplinary literacies do secondary mathematics teachers draw on when teaching mathematics?*
2. *How can an early-phase coaching program work to strengthen secondary mathematics teachers' disciplinary literacy learning?*
3. *How does an early-phase coaching program contribute to mathematics teachers' disciplinary literacy learning?*

5.1 Themes and Sub-Themes in the Study

The relationship between the study's research questions, themes, and sub-themes as discussed in the three findings and discussion chapters is outlined in Table 5.1.

Table 5.1

Themes and Sub-Themes in the Study

Theme	*Teacher as learner* Chapter 5	*Teacher as guide* Chapter 6	*Teacher as collaborator* Chapter 7
Sub-themes	Increasing awareness of disciplinary literacy	Engaging, challenging, prompting, and cueing	Engages with colleagues
	Working in different ways	Giving options	Supportive of colleagues
	Being coached for professional learning	Providing student collaboration opportunities	Advocates for coaching
	Recognising students' needs	Modelling	
	Experimenting		

In this chapter, Chapter 5, discussion of sub-question one is the focus of the following section, using data predominantly drawn from the first focus group and the first round of individual interviews with participants.

5.2 Research Sub-Question 1: *What disciplinary literacies do secondary mathematics teachers draw on when teaching mathematics?*

As discussed in Chapter 2, disciplinary literacy is considered to be the particular receptive and productive skills required to access discipline-specific content, which is the literacy of a particular subject or domain (Elish-Piper et al., 2016; Hynd-Shanahan, 2013; Moje, 2007; T. Shanahan & Shanahan, 2008). Elish-Piper et al. (2016) acknowledge the difficulty of using a disciplinary literacy approach for secondary teachers, noting that "the challenge of a disciplinary literacy approach to instruction is making expert practices accessible to students, who are most often novices in the disciplines" (p. 4). Data analysis revealed five types of practices teachers shared in the first focus group and individual interviews. The first four practices were formatting, writing, and setting-out conventions (5.2.1); problem-solving processes (5.2.2);

vocabulary support (5.2.3); and memory devices such as mnemonics or acronyms (5.2.4) to help students remember steps in a process. The fifth practice, which Harry and Pete discussed, was providing students with context and relevance (5.2.5). These practices are examined and illustrated using extracts from participant data in the following sections.

5.2.1 Formatting, Writing, and Setting-Out Conventions

One of the first questions asked of the focus group was: *What type of reading, writing, thinking, and processing do you think is most valued in mathematics? Is there something that you think is particular to mathematics?* In response, Sally, Harry, and Pete talked about the importance of clear setting out and written communication, such as book work and writing. When I enquired further about whether the school had any writing or thinking processes, or cohesive, consistent approaches to thinking through or stepping out problems, Harry (P2) stated: "Of all the areas that you touched on, writing and setting out a problem would probably be the most uniform across the school, classroom to classroom." He justified this by saying, "I think all teachers are fairly pedantic about that because we all understand the value of communicating thoughts mathematically on the page in a certain way." Pete noted:

> So even just anecdotally, when the Grade 11s came in for Essential Maths last year, I was doing the first couple of questions and they say, "Oh sir, do we need to put the justification at the end of this one?" And so, they've obviously been well taught, you know, over a number of years. (P4, Focus Group 1)

Pete shared this observation to reinforce that setting out and formatting was a consistent expectation and students had brought this knowledge with them into Year 11.

5.2.2 Problem-Solving Processes

The second way teachers in the focus group felt they were teaching students to work mathematically was by teaching a problem-solving framework from the QCAA (2019) in senior school (Years 10, 11, 12) after gradually progressing it into junior school (Years 7, 8, 9). Formulate, solve, evaluate and verify, and communicate (QCAA, 2019, p. 14) is the standard structure for senior mathematics assessment at Reservoir State High School. Having taught senior mathematics, Harry and Pete were able to reflect on the use of the framework as a way of organising and structuring mathematics

assignments. However, Harry noted, "Everyone is doing that; it takes a different form in everyone's classroom though. I'd say that everybody is using a model to do their problem-solving. But whether it's uniform across the school, I'm not sure about that." The influence of the QCAA framework began to emerge during further conversations. George was not present for the first focus group; however, in his interview, the framework was referred to.

QCAA (2022) mathematics syllabi state that the terms *formulate*, *solve*, *evaluate and verify*, and *communicate* are four key criteria on each mathematics instrument-specific marking guide in Year 11 and 12 problem-solving and modelling tasks. As previously discussed in Section 2.6.1.2, the QCAA provides this problem-solving and mathematical modelling approach based on Polya's four-step model (Polya, 1957), using a fully annotated, four-stage figure in the senior mathematics syllabi of General Mathematics (QCAA, 2019, p. 14), Essential Mathematics, Mathematical Methods, Specialist Mathematics, and the Numeracy short course (QCAA, 2022). Harry commented, "If I mention those four words to my students, like if you asked them and interviewed them, 'What does formulate, solve, and evaluate mean?' they'd say, 'Oh they're the headings on the assignment that we're doing' ". In light of the agreement between the three participants in the focus group discussion, it seemed this procedural, structured process was a shared expectation within the mathematics department. Given that the participants taught across six different year levels, the use of a common problem-solving approach was part of a shared repertoire of knowledge in the mathematics faculty, developed through a joint enterprise which incorporated the language of their CoP. The sharing of resources and use of a common language support members to negotiate meaning and understanding within the group (Wenger, 1998). A shared repertoire means that the teachers engaged in a joint enterprise, drawing on their language and the language of the CoP to communicate with one another, sharing resources for negotiating meaning and understanding.

Although George was not present for Focus Group 1, his first individual interview included some of the same questions posed to the group. George was asked: *In this school is there a common way that you would all teach students how to read and interpret mathematics problems or mathematics language?* (RC, P3, Ind. Int. 1). He responded, "I think each teacher uses the strategies that work for them, although we are, I think we're doing that this year. Using the QCAA formulate, solve, evaluate

and verify, communicate." While noting the expectation of the mathematics head of department to use the four-step QCAA model, George emphasised the importance of incorporating other strategies and skills into problem-solving. As part of participation in a community, or engaging in joint enterprise, the teachers developed and shared practices. Insight into George's thinking about the QCAA model, and some disciplinary literacy implications underpinning his mathematics instruction is revealed in this excerpt:

> My concern with it is, because that's a linear model, how do you basically write up the problem-solving modelling task as an assignment? It might not necessarily directly apply to tackling a short-response, problem-solving question where you might work through those steps in a linear fashion. I sort of feel more like this work is about students working iteratively, and returning to the text, and highlighting further elements, and examining relevance, significance, and then working to develop arguments. And then evaluating their progress and then returning to the text. It's more metacognitive than following a procedure to solve a problem. (P3, Ind. Int. 1)

Of interest is George's stated concerns about using a highly structured and procedural process. Ortiz (2016) contends that a one-size-fits-all or direct instructional approach stifles potential critical thinking, creativity, or investigation skills. This type of approach can exclude some students from mathematics learning (Ewing, 2011). Using a linear model is contrary to the belief of some researchers that students can work "in different directions through the subject matter" (Brown & Renshaw, 2004, p. 135). For example, narrowing the instruction to the QCAA flowchart model could result in students replicating or reproducing what has been explicitly taught by the teacher or learnt from a textbook.

Since 2020, the use of the QCAA framework at Reservoir State High School has begun to filter down to the junior classes (Years 7, 8, 9). Sally noted the challenge for students when she said:

> It [formulate, solve, evaluate and verify, communicate] is for problem-solving, the four steps. But it doesn't help kids break down the worded problem. It structures their answers, it doesn't actually help them to identify what they've got to do, how they've got to do it, what's expected in their justification. It doesn't do that in there. (P1, Focus Group 1)

Sally's comments indicate that she was aware of the challenge for students of comprehending and interpreting worded problems. Additionally, her comments suggest she did not believe a linear process alone was going to build her students' skills as it did not go beyond the literal task to support them with how to solve it or explain their reasoning. Analysis of data revealed that the participants benefited from their collaboration and resultant conversations during the coaching program. For example, as a junior mathematics teacher, Sally was able to share her concerns, as was George.

Although the QCAA flowchart model is not linear in structure, from the participants' interactions in the discussion, it seemed that teachers at the school viewed it as a linear concept. The benefits of having a CoP, where substantial conversations about classroom pedagogies, the imposed or expected ways of working, vocabulary expectations, and processes to support students' mathematics learning can occur, facilitated the sharing of professional reflection and learning. The expressed doubts by two participants about a perceived prescriptive problem-solving model were indicative that the disciplinary literacy lens informing their involvement in the coaching program was resonating with their practice. Furthermore, within the CoP, the teachers began to share insights and started using different methods and new pedagogical practices. This form of PL is indicative of the shared repertoire of the CoP (Wenger, 1998). Kise (2009) posits that PD which supports teachers to experience learning is more likely to lead to actual changes in practice than PD which provides teachers with information. Based on this understanding, the RC considers that these substantive conversations could be guided by a coaching culture within schools and teaching teams.

5.2.3 Vocabulary Support

Participants referred to mathematics terms and key vocabulary when discussing practices and strategies to support student learning. Harry noted the significance of vocabulary when he said, "Vocabulary becomes really important. Like they come from primary school knowing 'divide' but they may never have heard of 'quotient' " (P2, Focus Group 1). What Harry may be referring to in this example is the range of different terms, or synonyms, for mathematical operations and the challenge this presents for some students. The Australian Curriculum provides a glossary of mathematical terms (ACARA, 2021b), which defines key terms for students in Foundation (Prep) to Year 10. Interestingly, the terms *multiply* and *divide* are not

featured in the glossary (ACARA, 2021b). Ewing et al. (2011) refer to the reciprocity of language between students and teachers which exists within the classroom. Social interactions and shared language frame the learning of mathematical understanding of vocabulary for students via reasoning, argument, and problem-solving. Through the CoP lens, this classroom community shares language and practices which create knowledge of mathematics. Sally added another example of synonyms in mathematics vocabulary when she suggested "the product of" instead of multiply (P1, Focus Group 1). While this is not suggesting students have not been taught these terms, these examples imply that secondary mathematics teachers should teach vocabulary related to disciplinary content to extend students' knowledge of key terms and processes beyond add, subtract, multiply, and divide, and use synonyms interchangeably.

The teaching of vocabulary is important for comprehension, particularly when addressing adolescent literacy (Lee & Spratley, 2010). Within the scope of this study, literacy and its connection to numeracy is a foundation for exploring mathematical understanding. Attard (2022) directly addresses the challenge with the required literacy levels for mathematics in her recent PETAA webinar presentation when she states there are "so many layers around literacy, numeracy, and mathematics" (Attard, 2022, 3:53). When reading and interpreting text, the vocabulary knowledge of the reader can directly impact the level of understanding, and overall difficulty of a text is determined by the number of difficult words it contains (Stahl, 1986). Attard (2022) argues that literacy is a barrier to numeracy, thereby blocking some students from access to the understanding of mathematical concepts. The Australian Curriculum (ACARA, 2021a) identifies word knowledge as one of six interrelated elements in the literacy capability. Where mathematics differs from other disciplines is the perceived difficulty of some words, which have everyday meanings in other contexts but mean something technical in mathematics, such as *face*, *cubed*, or *prime* (Adams, 2003).

During the previous vocabulary discussion, Sally observed that she covered "all the other words for adding" in an ad hoc way (P1, Focus Group 1). Sally and Harry felt that perhaps vocabulary instruction could be done more pedagogically so that students were able to build their access to mathematics questions without a barrier. When considering this reflection, the work of Stahl (1986) is relevant, as he recommends three principles for effective vocabulary instruction: that students are provided with usage *and* word definitions; deep processing and connections to known words and concepts is

encouraged; and students should have multiple exposures to learn new vocabulary. Pete concluded that if vocabulary knowledge was an issue for some students, it was hard to know if their attempts in assessment tasks were related to content knowledge of mathematics or a literacy issue. Attard (2022) acknowledges this uncertainty as a major issue in mathematics classrooms when she points out that literacy is a barrier to numeracy and therefore access to understanding of mathematics concepts more broadly. Pete noted, "It's hard to know what you're assessing." Developing students' mathematical vocabulary and language through participation in classroom activities as a form of CoP is significant (Ewing, 2004; Lave & Wenger, 1991; Brown & Renshaw, 2004). By learning to talk and participate in mathematics, students become part of that community with its shared repertoire and practices. When reflecting on practice in the context of a social theory of learning (Lave & Wenger, 1991; Wenger, 1998), that is, the talking and sharing which encourages a collaborative approach to learning, there was little evidence in the focus group discussion to indicate this was happening consistently.

After acknowledging the importance of vocabulary for mathematical literacy and comprehension, it seemed Sally, Harry, and Pete used different classroom strategies and mostly a direct instruction approach. Teachers' emerging awareness and a keen interest in pursuing a disciplinary literacy approach showed participants may be moving away from the teacher as the central authority of mathematics vocabulary and knowledge. Fullan and Knight's (2011) acknowledgement of coaches as agents for change supports a coaching approach to introduce disciplinary literacy learning for the teachers.

Further discussion and analysis of the significance of vocabulary and mathematical language occurs in Chapter 6, when the teachers developed an emerging awareness of the disciplinary literacy of mathematics.

5.2.4 Memory Devices

During focus group discussion, Sally, Harry, and Pete reflected on the use of mnemonics or acronyms in a disciplinary literacy context. Sally shared the CUBES strategy (Twinkl, n.d.) with the focus group, a process she used in junior classes to help students interpret word problems. CUBES (and its variation, CUBED) are widely available on educators' blogs and shared freely among teachers. As explained in Section 2.6.1.1, the acronym represents the following process: "C", circle all numbers and labels; "U", underline the main question in the task; "B", box the key words; "E",

eliminate extra information; and "S", solve and check your answer. CUBES provides a starting point for students to access the most relevant information in a worded problem. Sally stated, "for understanding word problems and accessing them we use a CUBES strategy in Year 7 and 8, which is a very basic circle, underline etc. And we use the senior problem-solving method from Year 7 to have them structure their problems" (P1, Focus Group 1). Attard (2022) observed that students with low literacy levels, or students from EAL/D backgrounds, typically go straight to numbers and avoid written language cues in worded problems. This situation can lead to misconceptions and students using the wrong operation. Within the CUBES strategy, important words are outlined along with numbers and symbols; however, relying on the appropriate level of literacy as the starting point is the key.

Discussion in Chapter 2 about CUBES (and other set ways of working) revealed the perception that students may think a one-size-fits-all strategy always leads to the answer. While CUBES may lead students to an answer, and there are other ways of reading, thinking, and processing a mathematics problem, in this study CUBES became a common starting point for three participants. Another approach to support student understanding is a mathematical storytelling approach called MAST (Matthews, 2018). This strategy has been devised to support students to develop abstract mathematics concepts. By using real-life examples and the telling of stories, Matthews (2018) argues that students are able to use and create symbols, incorporate mathematical elements in their language and stories, and share their own symbols to gradually develop equations. A type of storytelling approach is a strategy used by two of the study's participants, as explained in the next section.

5.2.5 Providing Context and Relevance

The final disciplinary literacy strategy, which was discussed in the first focus group by Harry and Pete, was the importance of providing students with context and relevance for mathematics learning, and is an important engagement strategy. Widjaja's (2013) research refers to "contextual problems", and notes that good contextual problems allow a range of responses, which in turn can support social learning of mathematics. Harry explained his approach as "the ability to weave some sort of contextualisation into mathematics through storytelling, through engagement at some personal level so that they [students] think, this is relevant to me". Throughout

subsequent classroom observations, the RC observed instances where the teacher would provide background context, for example, at the start of a new topic. Harry's introduction to profit and loss in Year 8 mathematics was a good example of this strategy. Harry noted to the RC in the post-observation discussion that students never say, "Sir, when would we ever have to use this?" In an attempt to keep his Year 12 Essential Mathematics students engaged, Pete incorporated real-world situations and contexts. The Term 1 assignment included outlining the scope of a construction project, including researching and pricing materials and quoting costings of paving stones. Widjaja's (2013) findings noted that it was important to make contextual problems specific for the students so that they can see themselves and their world in the learning. The construction project concept for students in Year 12 could be a way to align with the age of senior students, some of whom will potentially soon enter the workforce.

In the final focus group and interview, Pete acknowledged the way the coaching project had stimulated his interest in finding out more about disciplinary literacy practices to support his students; this insight reinforced the notion of coaching as an enabling influence for further PL to occur.

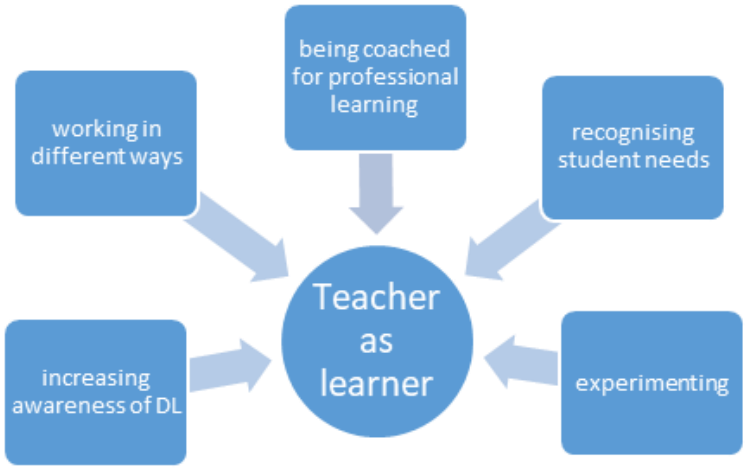
The next section outlines the first key theme, *teacher as learner*, and its five sub-themes.

5.3 Theme 1: *Teacher as Learner*

The notion of teacher participants as learners is at the centre of this theme. There are five sub-themes within the *teacher as learner*. Thematic coding and analysis of focus group and interview transcripts, along with the RC's reflective journal entries, produced the following sub-themes: increasing awareness of the disciplinary literacy of mathematics; working in different ways; being coached for PL; recognising student needs and addressing gaps in learning; and experimenting with mindset and a willingness to be vulnerable. Theme 1 and its sub-themes are represented in Figure 5.1.

Figure 5.1

Theme 1: Teacher as Learner



Note. DL = disciplinary literacy.

The *teacher as learner* theme is derived from data analysis from three types of interactions: (a) conversations in the focus group, (b) the RC's reflections, and (c) interactions with individual participants. Initially, in the focus group and interviews, teachers talked mainly about their students and their learning needs. The four participants showed a willingness to engage with a different way of working through the coaching program, and a desire to address gaps in their students' learning. This suggested to the RC that they were comfortable in identifying themselves as adult learners, and that they had a good perception of their self-efficacy. B. Tschannen-Moran and Tschannen-Moran (2011) posit that good coaching programs focus on adult learning principles and are teacher-centred. Successful coaching programs in schools require expertise, collaboration, differentiation, and insight into adult learning, along with authentic relationships (Hanover Research, 2015).

The first theme has been presented in Table 5.2. Sub-themes and supporting excerpts from data indicate ways in which participants related as learners to the opportunities presented in this study.

Table 5.2

Theme and Sub-Themes, Teacher as Learner

Sub-theme	Theme 1: *Teacher as learner* – illustrations of practice
Sub-theme 1: Increasing awareness of disciplinary literacy	Gee, you know, it seems to be the reading that's the problem. I reckon that only sort of occurred to me midway through last year, and I think I'm at a point where I'm ready to learn how to teach literacy to improve their maths. (Pete, Focus Group 1) I think for me, just learning about mathematical discourse and how we can support our students to become more confident to talk about maths concepts and maths processes, and even being able to describe the skills that they've learnt, has kind of opened a bit of a window and I just want to see more. (Sally, Focus Group 2) I think in the past I would have thought about the number one thing going into that lesson: how am I going to unpack the maths? Going into a problem-solving lesson now, it's how am I going to make the language accessible for the kids? (Harry, Focus Group 2)
Sub-theme 2: Working in different ways	I think actually having a concrete strategy where I could use a language that's common to the whole class, that's interesting. I'd like to try that. (Pete, Ind. Int. 1) What do I need to know to teach disciplinary literacy? (Harry, Focus Group 1) I think some of these things, I didn't have names for them, vocabulary labels for them before we did this, but I think some of the things we're talking about are the way that I always envisaged that I would instruct students in mathematics. (George, Focus Group 2)
Sub-theme 3: Being coached for professional learning	[The coach is] a shortcut to good resources, and someone knowledgeable who can suggest ideas, give you some direction and how you can take your lessons further in that area. (Sally, Focus Group 2) I'm of the belief that if you have people in your classroom watching you work, no matter whether it's a coach, a pre-service teacher, you are just on show, you are better at your game than if you are not on show. For me it's like a step-up type of thing, so that's the buy-in for me, I think. (Harry, Focus Group 1) I think it's that one-on-one time, in the coaching way of working that allows you to kind of speak out loud without feeling too weird about speaking out loud. And hear your own thoughts a bit more, and have them reflected back to you with some other perspectives. And if someone you're doing that with is quite knowledgeable in that area then I think you can make some big gains in a short period of time. (George, Focus Group 2)
Sub-theme 4: Recognising student needs	Sometimes we talk about our teaching practice and what we do as teachers, but I think doing this [coaching] is addressing a very specific student need, and I think that is probably a higher level teaching skill. (Pete, Ind. Int. 2) I want them to be like, "Oh yeah worded problem, I'm just going to read this and then I'm going to pull out my red pen and my highlighter and I'm going to start pulling apart the question so I know exactly what I am being asked to do." And I just want that to become a way of being for them in maths. (Sally, RC, 11/2/21)

Sub-theme	Theme 1: *Teacher as learner* – illustrations of practice
	I think that's what comes from the think-alouds and the think-alongs that we do when we model the way we deconstruct a text in mathematics, if you like. And we highlight, or we model the back alleys and the dead ends that we're experiencing in that process. Even if that means making it up if you like, to demonstrate those pathways of thinking and cognitive regulation that lead us back to knowing we're not on the right track. (George, Ind. Int. 1)
Sub-theme 5: Experimenting	I suspect it's to do with their [students'] comprehension, and being a sciencey person, I just want to control the variables and try something to see if it improves. (Pete, Ind. Int. 1)
	I noticed that I felt uncertain in myself and that kind of trepidation trying something new. I noticed I like it though, because it made me reflect, a lot, on what I was doing, because everything was kind of a bit different. (Sally, Ind. Int. 2)

The literature acknowledges the importance of teacher efficacy and its impact when staff are faced with new ways of working, or require motivation to embrace new classroom instructional practices (M. Tschannen-Moran & Hoy, 2001). In their research, Nugent et al. (2016) combined a summer institute PD with follow-up coaching for middle and high school teachers, and noted that teacher efficacy significantly improved in response. The authors noted that the critical element for teachers was the ongoing nature of support and feedback from a coach while practising new skills back in their own classrooms. Being prepared to adjust or experiment with classroom pedagogy, and for each teacher to be vulnerable while learning new ways of working to build awareness of disciplinary literacy, typifies the theme of *teacher as learner* in this study.

5.3.1 Teacher as Learner: Increasing Awareness of Disciplinary Literacy

Findings from the first focus group and individual interviews reinforced the notion of an increasing awareness of disciplinary literacy for all four mathematics teachers. Prior to the focus group the RC deliberately did not provide readings or information about disciplinary literacy, as the intention was to support authentic discovery and learning through participation in the research project. However, part way through the session, a package of materials and resources was provided to each participant. Included in this package was a glossary of key terms related to this study (disciplinary literacy, coaching, focus group, community of practice, content-area literacy, case study), some disciplinary literacy concepts from three journal articles,

and consent and feedback forms. The RC also created two handouts from key literature about disciplinary literacy as a way of introducing aspects to the mathematics teachers. The pyramid diagram in Chapter 2, Figure 2.1, titled "The Increasing Specialisation of Literacy Development" from T. Shanahan and Shanahan (2008, p. 44), was one of the documents provided and explicitly referred to during the focus group. A summary table compiled from Hynd-Shanahan (2013), which compared and contrasted two key literacy terms – content-area literacy and disciplinary literacy – was also presented by the RC. This was the study participants' first direct exposure to disciplinary literacy material provided by the RC (see Appendix E for a complete list of the materials).

The opening focus group question – *What type of reading, writing, and thinking is most valued in mathematics?* – seemed to be interpreted broadly. The teachers mainly discussed the topic through the lens of reading, as Harry stated early in the session, "What we find in a lot of our mathematics classes is that the students can do the maths" (P2, Focus Group 1). From Harry's quote, the implication is that once the problem has been analysed and interpreted, the students seem to be able to work out the part with numbers and operations. Throughout the discussion, participants reiterated a general belief that an equation or series of numbers with operations was generally more palatable to students than a short paragraph or number sentence with worded information. As previously discussed in Section 5.2.4., Attard's (2022) observation that some students look mainly at numbers and symbols (as coded forms of text) in worded mathematics problems if they have a literacy problem reinforces the notion that literacy can be a barrier to learning the concepts within worded parts of the question. Attard (2022) further points out the importance of peer support in cooperative problem-solving tasks; small groups allow students to hear mathematical language, reasoning, and concepts being discussed by peers and the teacher.

Continuing with the notion that some students prefer equations rather than worded questions, Pete talked about his Year 11 and 12 students' reluctance to read in mathematics: "I have talked about this over the last year or so [with Harry] and we suspect maybe it's actually a literacy issue" (P4, Focus Group 1). Pete noted students' reluctance to engage with reading independently, as he felt some students would do well if a question was read to them, "which sometimes I do when I'm at the front of the class, but then when I throw it over to the students, it's the reading that's the problem, not the interpreting" (P4, Focus Group 1). In initial reflections about

teachers' responses the RC identified there was a realisation about reading in particular from the teachers, which might influence their thinking regarding learning more about disciplinary literacy (RC, 8/2/21). Furthermore, the general capabilities of the Australian Curriculum (ACARA, 2021a) state that each subject area or discipline has unique literacy requirements. The RC's journal entry noted that teachers may be grappling with how to go about implementing this aspect of the Australian Curriculum (RC, 8/2/21). The RC further noted some reflections about senior students in Pete's classes and his description of their reluctance to individually attempt worded problems, and wondered about past experiences in mathematics learning, for example, whether in the past they had engaged in mathematics talks in classrooms (RC, 8/2/21).

Analysis of the focus group discussion indicated that the type of reading required in mathematics was complex and teachers felt some students were resisting it. Sally shared experiences from her Year 7 classes, related to EAL/D students:

> If you're subtracting something … if English isn't their first language, kind of interpreting and understanding where that subtraction actually sits in that mathematical sentence can be a real trick for them. Yeah and lots of kids, not just EAL/D kids. (P1, Focus Group 1)

Sally's observation about some students' language barriers are acknowledged by research into intercultural understanding and mathematics. The range of symbols and operations which form the language of mathematics has origins in different cultures; however, not all cultural groups' language needs are accounted for in mathematics classrooms (Ewing, n.d.). Simplifying the language in a question could encourage participation for ELLs. Therefore, teachers' awareness of integrating content from diverse cultural groups, or ensuring that EAL/D students have equal opportunities in accessing learning, can support the underlying literacy and numeracy levels of all students.

When Harry shared his observations about students coming from a range of primary schools to a secondary school, he noted the way the transition may reveal inconsistencies with mathematics vocabulary knowledge. As discussed earlier in this chapter, Harry's observation about some students knowing the term divide but not knowing the term quotient supports the discussion about unique literacy requirements in mathematics. For Sally, Harry, and Pete, it seemed that a combination of factors, such as students' limited beliefs about or negative past experiences of mathematics,

whether a student is learning in their first or other language, and new vocabulary demands, may lead to a perception of reluctance to read and engage with worded problems during mathematics classes.

The same opening question was posed to George (P3) during his individual interview, which was an extended interview session incorporating aspects of the focus group discussion. To reiterate, this question was: *What type of reading, writing, and thinking is most valued in mathematics?* George's response included some further questions:

> It's abstract thinking, deduction, deductive reasoning, and analytical thought. How do we take a written story and use an analytical thought process to break apart the elements; assign them significance and relevance? Then use that as the basis for selecting knowledge and literacy. (P3, Ind. Int. 1)

While George's response emphasised thinking processes, he also added, "It's in that decoding/encoding space which has got a lot of analytical thought, abstract reasoning and the like." The RC posited that the other participants were "pretty united in the fact that they felt [reading] was a weakness of the mathematics student" (RC, P3, Ind. Int. 1). George further conceded that the ability to decode and interpret worded problems was a widespread challenge for students. He discussed the notion of symbology and making connections between the worded text, numbers, and symbols, noting that "[we've] got two different languages that you're dealing with" (P3, Ind. Int.1). While George used the term languages, perhaps it would be more accurate to refer to modes of representation, given that numbers, symbols, letters, words, and diagrams can combine in different ways to represent meaning in mathematics. George's observation is well supported by the literature with regard to complexity in mathematics language. Gough (2007), Quinnell and Carter (2013), and Doerr and Temple (2016), among others, have researched mathematical language and its apparent challenges for school students due to the combinations of numbers, symbols, and modes.

To further highlight this perception about the complexity of reading and interpreting in mathematics, Pete shared an anecdote where he and Harry regularly engaged in staffroom discussions about their students. Harry and Pete shared their perceptions about students' reluctance to engage with worded problems, yet the same students would happily work on questions with mathematical notation (numbers, operations). Pete related the nature of their interactions as follows:

> Gee, you know, it seems to be the reading that's the problem. I reckon that only sort of occurred to me midway through last year, and I think I'm at a point where I'm ready to learn how to teach literacy to improve their maths. (P4, Focus Group 1)

The preliminary focus group discussion about the complex nature of reading and processing in mathematics was foreshadowed in detail in Chapter 2 (Section 2.6.1 Mathematical Literacy). The situation Harry and Pete talked about, that is, students showing reluctance to read and interpret worded problems in mathematics, has been extensively researched (Adams, 2003; Doerr & Temple, 2016; Gough, 2007; Meiers & Trevitt, 2010; Phillips et al., 2009; Quinnell & Carter, 2013). Indeed, it is worth reinforcing the observation by the COAG *National Numeracy Review Report* in 2008, which noted, "for many children, mathematics is seen as a foreign language" (COAG, 2008, p. 32). The participants' experiences align with outcomes documented in the literature.

During the final data collection phase (final focus group, final individual interviews), it became evident that participants had developed an increasing awareness of the disciplinary literacy of mathematics. George led the discussion in response to the first question: *What aspects of this coaching program contributed most to disciplinary literacy learning?* He noted, "that initial information we got in order to get us off the ground about what disciplinary literacy learning was, was very helpful" (P3, Focus Group 2). Once teachers had prepared for and taught specific lessons, the focus on disciplinary literacy learning for students seemed to be an extension of their own learning. Sally's insights around mathematical discourse, the mathematical communication that occurs in a classroom (NCTM, 2010), reflected her growing confidence when she noted:

> I think for me, just learning about mathematical discourse and how we can support our students to become more confident to talk about maths concepts and maths processes, and even being able to describe the skills that they've learnt, has kind of opened a bit of a window and I just want to see more. (P1, Focus Group 2)

The aspect of *teacher as learner* typified by an increasing awareness of disciplinary literacy is evident in the discussion with Harry in particular. Harry's approach to teaching problem-solving evolved in response to his experiences during

this research project. The RC's reflective journal (RC, P2, 8/2/21) noted Harry's initial observations about notions of hidden meaning and unlocking the language of mathematics, along with the importance of vocabulary, back in the first focus group and individual interview: "Yeah, well the students need to not only interpret, I suppose, what question is being asked, but then there's a whole, let's say language inside mathematics" (P2, Ind. Int. 1). Harry used specific examples to elaborate on the need for students to be able to interpret a complex set of language and symbolic codes. Interestingly, after giving an example where order of operations changed when working with fractions, Harry was apologetic, stating, "now this gets away from literacy in maths a little bit" (P2, Ind. Int. 1). The RC noted that the thinking, knowing, interpreting, and communicating required of a mathematics student in Harry's example typified a disciplinary literacy approach in mathematics. Hynd-Shanahan (2013) states that students need to learn how to engage in practices to help solve specific problems, not just use a generic toolbox of strategies. By acknowledging that unique literacies require a disciplinary approach, and challenging early perceptions of disciplinary literacy, the notion that participants were developing their knowledge and understanding of disciplinary literacy for mathematics was confirmed.

Within the current study, as participants began to develop disciplinary literacy knowledge motivated by their students' learning needs, their new understanding of literacy for mathematics could be applied to other challenges. Franke et al. (2001) followed teachers' progress after a PD program focused on understanding students' development of mathematical thinking. A key finding from this study, framed as learning with understanding, was sustained change in teachers' classroom practices up to 4 years after the PD. Franke et al. (2001) were concerned not just with what teachers learn, but how they learn it, and the way new knowledge connects to existing knowledge, "reorganising knowledge to create rich integrated knowledge structures" (p. 656). The support of colleagues throughout this PL was considered by the participants to be a significant factor in their engagement with learning. The foregrounding of disciplinary literacy as a result of participation in a coaching program could be the start of sustainable changes in practices for the mathematics teachers.

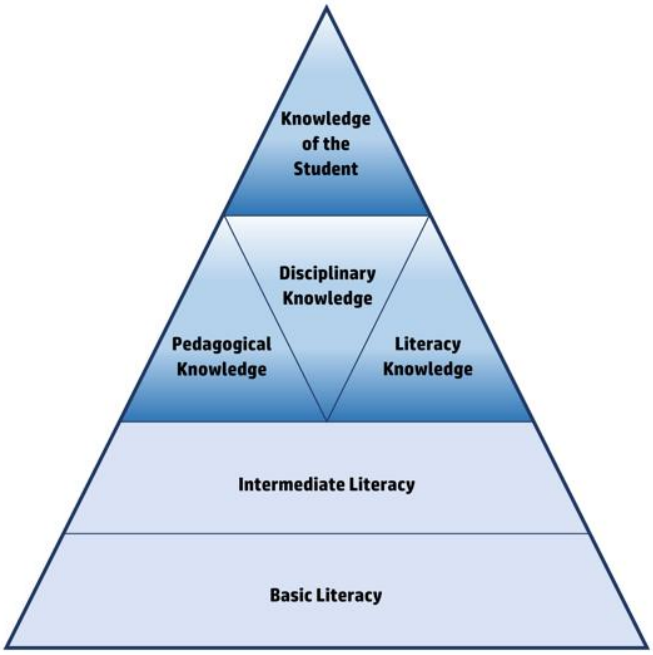
Over the course of the project, Harry's knowledge of disciplinary literacy instruction revolved around clarity of the language of mathematics. A growing awareness of mathematical literacy is evident in Harry's conversation:

> I think in the past I would have thought about the number one thing going into that lesson: how am I going to unpack the maths? Going into a problem-solving lesson now, it's how am I going to make the language accessible for the kids? (P2, Focus Group 2)

Elish-Piper et al. (2016) have extended T. Shanahan and Shanahan's (2008) pyramid depicting three layers of literacy instruction. Within the top section of the disciplinary literacy model, Elish-Piper et al. have included the following elements: knowledge of the student, pedagogical knowledge, disciplinary knowledge, and literacy knowledge (see Figure 5.2).

Figure 5.2

Knowledge Domains for Disciplinary Literacy Instruction



Note. From *Collaborative Coaching for Disciplinary Literacy: Strategies to Support Teachers in Grades 6–12* (p. 8), by L. Elish-Piper, S. K. L'Allier, M. Manderino, and P. Di Domenico, 2016, Guildford Publications. Copyright 2016 by Guildford Publications. Reprinted with permission.

In summary, Harry's question and the disciplinary literacy research draw together the four interconnected elements at the tip of Elish-Piper et al.'s (2016) figure. Harry's knowledge of his students and their learning needs, and the starting point of their literacy knowledge, coupled with his pedagogical knowledge, interact with his growing awareness of explicitly teaching the unique disciplinary demands of mathematics.

5.3.2 Teacher as Learner: Working in Different Ways

The mathematics teachers' willingness to work in different ways during the research project emerged as another interesting outcome of the *teacher as learner* theme. Despite one expressed outcome of the first focus group for the RC, which was to glean different types of disciplinary literacy practices from the mathematics teachers, the study participants seemed more interested in learning new strategies and practices. The RC's reflective journal (RC, 8/2/21) noted that there may have been a reluctance to share ideas on the spot, perhaps because individual teacher practices become automatic, or individual teachers may not think their own practices are particularly special.

A willingness to try working in different ways was apparent during the first focus group discussion. This was evident when Sally shared a strategy she taught to Year 7 students called CUBES (Twinkl, n.d.). As previously noted, the CUBES strategy consists of circling key numbers, underlining the questions, boxing key mathematics words, evaluating which steps to take (eliminating unnecessary information), and solving and checking. Pete (P4, Focus Group 1) indicated he wanted to trial CUBES with his Year 12 students by stating, "I think actually having a concrete strategy where I could use a language that's common to the whole class, that's interesting. I'd like to try that."

Initially participants referred to CUBES as a problem-solving strategy; however, during the individual interviews, the RC discussed the widely used QCAA problem-solving framework with Harry and Pete (formulate, solve, evaluate and verify, communicate; QCAA, 2019, p. 14). As previously discussed, this model is woven throughout all senior mathematics assessments at Reservoir State High School. Harry felt the CUBES strategy would sit within the formulate part of the QCAA model, suggesting that "the student reads the question and they don't know where to start. They have a poor understanding of how to formulate their response based upon their mathematical understanding" (P2, Ind. Int.1). Aspects of the coaching program underpinning this project meant that during the individual interviews, the RC was able to ask clarifying and probing questions to elicit responses. Asking questions is one of the key skills of coaching and becomes an important aspect of an effective coaching program (van Nieuwerburgh, 2017). Consequently, Harry's notion of CUBES as a problem-solving strategy was challenged by the RC during his interview. In response,

Harry observed, “this looks like an information organisation strategy” (P2, Ind. Int. 1). Ultimately, the RC and participant agreed that the purpose of CUBES was to help students interpret text and further guide them iteratively and systematically through the text to look for key information before any problem-solving could occur.

Previous experience as a literacy coach in a different school provided the RC with a range of resources and experiences, particularly about reading, which informed some of the practices in this project. For example, the RC shared a form of close reading strategy (Snow & O’Connor, 2016) used previously in mathematics literacy coaching. This strategy, generically referred to at the RC’s previous school as “the three reads”, was adapted and used successfully in mathematics by several teachers. This sharing of ideas and giving examples of strategies or processes (shared repertoire) is in line with a CoP, and additionally with the notion of the RC as a resource for teachers. From previous experience, the RC considered specific examples supported teachers to think more critically about classroom pedagogies and literacy approaches. For example, the three reads strategy/close reading can provide students with a systematic process to absorb dense information in a seemingly short mathematics question. The RC’s inquiry further examined if use of close reading in mathematics enabled students to better comprehend the mathematical language, terms, values, and symbols, which are usually quite tightly packed for brevity (C. Shanahan et al., 2011).

The literature about reading in mathematics is reflected in the real-world discussions between Harry and Pete. Barton et al. (2002) refer to special reading skills in science and mathematics, “skills that students may not have used in other content areas” (p. 25). They state that “helping students with mathematics and science texts … is not the same as teaching students to read. Rather, it’s helping students make sense of – and learn from – science and mathematics text” (p. 24). Harry’s observation, that CUBES looked like an information organisation strategy, confirmed the teachers’ developing awareness of disciplinary literacy in mathematics. Another factor often quoted in journal articles about reading and mathematics, which the RC was able to share with the teachers, is that mathematics texts contain more concepts per word, per sentence, and per paragraph than other disciplines (Barton & Heidema, 2000) and that mathematics reading is not linear but rather requires students to be able to read left to right, top to bottom, and from other locations on a page such as tables or graphs (Bossé & Faulconer, 2008). C. Shanahan et al. (2011) conducted research with experts in three

disciplines and found that an expert mathematician reads text and graphics with equal importance. This information is a vital element, and noted by the mathematics teachers, to model expert reading in their subject for teaching students how to read like a mathematician.

Participants in the focus group were not familiar with close reading/three reads, and at this point it was interesting to note Harry expressing reservations about it:

> I'm not sure if it's a one-size-fits-all mechanism. Because if I was told to do the three reads in class, even though I can see the absolute value in that strategy, I would have just tuned out, I'm not reading the question three times. (P2, Focus Group 1)

Harry did acknowledge that CUBES and three reads could be applicable in different classes, an idea which was reinforced by Sally: "I think at different stages, there's probably different levels of appropriateness for this sort of thing" (P1, Focus Group 1) The RC's reflective journal noted the focus group participants' beliefs about students' ability to read and interpret worded mathematics problems (RC, 8/2/21). When the RC attempted to broaden the discussion, for example, by introducing the topics of thinking or writing mathematically, these topics did not seemingly generate as much focus. The RC's impression of the focus group discussion was the general agreement of Sally, Harry, and Pete that students' engagement and confidence in mathematics were impacted by their success with reading and interpreting worded mathematics problems.

At the end of the first focus group, participants expressed a desire to be introduced to some literacy strategies and approaches in order to learn how to support students to read and interpret texts. This quote from Harry summed up the general feeling: "What do I need to know to teach disciplinary literacy?" (P2, Focus Group 1). It was evident that the teachers wanted to try something new and were prepared to be exposed to new theory about teaching mathematical literacy while trialling strategies to foster disciplinary literacy with their chosen classes. Sally's response was indicative of this desire when she reflected: "I think it's really viable; I think it will make me a better teacher" (P1, Focus Group 1). Further, Pete noted:

> It's a deliberate practice, where we can have set-aside times to talk about it, and deliberately focus on even just one strategy that you might come in and have a look at how it's going, that we can talk about afterwards. (P4, Focus Group 1)

During the first interview with George, his understanding of learning, knowledge, and aspects of mathematical thinking became apparent. As this interview was a combination of focus group and interview, the nature and depth of discussion varied when compared to the group session. Despite this, George willingly approached disciplinary literacy coaching fully prepared to try a different way of working, with an understanding that mathematics presented students with unique literacy challenges.

George's ability to articulate an individual position about metacognition and mathematical thinking processes resonated with me as the RC and highlighted a tension with the school's alignment to the problem-solving approach preferred by the QCAA. The previously mentioned model – formulate, solve, evaluate and verify, communicate (QCAA, 2019, p. 14) – follows a somewhat linear path for mathematical thinking and processing. George expressed that it was more important for students to be able to work iteratively, returning to the text to examine significant aspects and evaluate their progress. He was referring to the core concepts in the work of Shoenfeld (1992), who noted the propensity for school students to just pick a strategy and then apply it. In contrast, expert mathematicians would move back and forth, switching between possible ways of working, checking, and re-reading. Shoenfeld (1992) highlights the inexact nature of problem-solving in mathematics. This issue resonated with the other participants' concerns about problem-solving in the classroom and expectations from the school system to use a specific approach.

The RC noted George's goal to trial different ways of working in his Year 8 mathematics classroom while learning about the disciplinary literacy of mathematics. At the conclusion of the project, George expressed the following in response to a question about what had changed in his teaching:

> I think some of these things, I didn't have names for them, vocabulary labels for them before we did this, but I think some of the things we're talking about are the way that I always envisaged that I would instruct students in mathematics. I think we constantly fall into the trap of our unit outline, and our curriculum, and our content, and our skills and procedures and we don't spend enough time on some of the other things. It was good to have the permission to set aside the time to do some of these things and learn about what to call them and how to do them better. (P3, Focus Group 2)

George's insights at the end of the project reflect the tensions between top-down, systemic expectations of the education system, such as the mandated Australian Curriculum content, and the time to spend working on developing his ability to meet individual students' learning needs.

E. Cox (2015) noted the importance of the adult learner, "a mature, motivated, voluntary and equal participant" (p. 27) with the ability to control and direct their own learning. E. Cox's paper explains how the coach can use adult learning principles to stimulate shifts in teachers' thinking, leading to different ways of working. To summarise this sub-theme, the presence of a coach or facilitator can encourage teachers to persevere and change practices through new experiences. The next section examines the *teacher as learner* theme through the lens of a coaching approach to PL.

5.3.3 Teacher as Learner: Being Coached for PL

The importance of a trusted relationship between teacher and coach, and how reflective practices support a coaching program, was another key finding in this study. Knight's (2009, 2010) partnership approach, comprising the seven principles of equality, choice, voice, dialogue, reflection, praxis, and reciprocity, resonates with findings in this section. A trusted partnership between coach and teacher underpins the experience of ongoing professional disciplinary literacy learning.

While noting that trust is a difficult concept to define, Markovic et al. (2014) conducted research into the impacts of trust in coaching on performance and strategic success for individuals and organisations. They identified three critical factors for trust development, that is, ability, benevolence, and integrity (Markovic et al., 2014). In their study, ability refers to competency, benevolence means the good intention of the individual, and integrity is linked to principles and accountability. The RC was aware of the research into trusted relationships in coaching programs (Campbell & van Nieuwerburgh, 2018; Knight, 2009, 2010; Markovic et al., 2014), so it became an integral part of the RC's interactions with participants. In order to support the teachers' disciplinary literacy learning through coaching, the RC had to demonstrate an ability to coach, despite not having the same level of mathematical content knowledge as the teachers. By developing interpersonal relationships, the teachers were prepared to take risks with their classroom practices, and in Harry and Pete's case, extend an open invitation to walk into their classrooms at any time, not just for scheduled observations.

Sally's comments provided insight into her growing confidence as a result of the coaching interactions when she said, "Having the opportunity to think aloud your ideas, and go through what you did better, or how you're going to implement something for the first time … helps you to grow your confidence a bit" (P1, Focus Group 2). When analysing the teachers' responses to focus group and individual interview questions about coaching for PL, it seemed that each participant had embraced the coaching program willingly to develop their disciplinary literacy awareness.

Building on the notion of trust in the coaching relationship, Kise (2009) argues that coaching is about creating "experiences that cause teachers to question their beliefs and make them aware of avenues for further growth" (p. 21). A key word in this quote is *experience*. Sally's experiences with coaching, both prior to the study and as part of her experiences in this project, seemed to reinforce the idea that coaching supports further growth. She noted, "[The coach is] a shortcut to good resources, and someone knowledgeable who can suggest ideas, give you some direction and how you can take your lessons further in that area" (P1, Focus Group 2). A coaching program, which includes cycles of observations and collegial discussion, provides teachers with experiences that traditional one-off PD sessions cannot emulate. When participants trust the coach's ability, benevolence, and integrity, they may be more open to a range of experiences like coaching, which can lead to deeper professional growth.

During the first focus group, Harry stated his position on having observers in his classroom when he said:

> I'm of the belief that if you have people in your classroom watching you work, no matter whether it's a coach, a pre-service teacher, you are just on show, you are better at your game than if you are not on show. For me it's like a step-up type of thing, so that's the buy-in for me, I think. (P2, Focus Group 1)

Harry alluded to the way having an observer in his classroom made him work to his best, and he automatically adjusted his teaching in the presence of an observer. This suggests that a coaching approach to PL could provide him with ongoing, timely feedback about the disciplinary literacy of mathematics, and links to a positive sense of agency. Bandura (2000) states the belief of personal efficacy is "the foundation of human agency" (p. 75). Bandura's (2000) research into efficacy provides insight into how participants commit to goal setting, how much effort they are prepared to expend, and their levels of perseverance. By welcoming people into the classroom, Harry

showed his openness towards observation and that he was comfortable about PL opportunities such as coaching.

To support teachers' reflective practices through the coaching program, observation lessons were intentionally planned to incorporate a disciplinary literacy approach in mathematics. As discussed in Section 4.3, a lesson observation template (see Appendix C) was used as a basic structure to capture aspects of disciplinary literacy instruction in the mathematics lesson, together with post-observation coaching prompts. Conversation notes were collected in the RC's reflective journal; these particular notes were not part of the data but were a way to reflect on teachers' experiences in the lesson. The following question prompts, adapted from Knight (2017) and a Growth Coaching International (2019) model, were incorporated in every post-observation coaching conversation:

- *How did the disciplinary literacy component of the lesson go today?*
- *What worked well? What else? And what else?*
- *What would you change? Why?*
- *What would that look like?*
- *What will you do next week?*
- *What do you need from me? How can we work together?*

The RC's reflective journal provided ongoing analysis of observation data, based upon coaching reflections and discussions.

To demonstrate the benefit of PL through coaching, which in this study consisted of classroom observations followed by a coaching conversation, George shared his experiences in the final focus group by stating:

> I think it's that one-on-one time, in the coaching way of working that allows you to kind of speak out loud without feeling too weird about speaking out loud. And hear your own thoughts a bit more, and have them reflected back to you with some other perspectives. And if someone you're doing that with is quite knowledgeable in that area, then I think you can make some big gains in a short period of time. (P3, Focus Group 2)

In summary, providing a consistent coaching framework for each participant enabled them to plan, deliver, and reflect on the disciplinary literacy aspects of the lesson with input from the RC. Importantly, each participant was able to make their own choices about the direction their learning would take, and engaged with

meaningful dialogue to further both parties' knowledge of the disciplinary literacy of mathematics.

5.3.4 Teacher as Learner: Recognising Student Needs

Recognising student needs was a sub-theme that emerged early in the analysis of the focus group and individual interviews. Participants seemed motivated to engage with coaching to support their own PL in order to enhance their students' engagement and understanding in mathematics. The following findings about the participants' willingness to engage with coaching are shared predominantly through the lens of the RC's reflective journal.

Evidence of teacher motivation was based on the fact that during post-observation conversations, all four teachers expressed a desire to help develop students' independence and confidence when applying their knowledge to a range of mathematics topics. For example, George noted that there seemed to be a jump between the skills required for reading a mathematics question and then interpreting what to do (RC, 5/3/21). George's conversations about what he would change and what that could look like included discussion about mathematical discourse and dialogic instruction (RC, 5/3/21). As George had researched and written the school's pedagogical framework prior to this study, he was referring to Brown and Renshaw's (2004) dialogic approach to learning and teaching, where dialogic techniques are used by teachers and students to bridge everyday ways of knowing with mathematical thinking and speaking about mathematics.

Sally reflected on her Year 7 students and the opportunity to create a social learning environment as a way of increasing student academic talk about mathematics (RC, 18/2/21). Harry wanted to support his students during the co-construction of the "profit recipe" as a way to increase student engagement during the profit and loss lesson (RC, 2/3/21). Pete's Year 12 classes presented a challenge, as his students seemed to engage with social learning processes, that is, peer or partner work and whole class discussion; however, when working independently, he noted a decrease in engagement (RC, 10/2/21). All four examples demonstrate the motivation of participants to engage with coaching to develop disciplinary literacy learning to address perceived gaps in student learning.

A key driver of any school's mathematics program is the curriculum, from which assessment cycles, reporting periods, and units of work are divided into discrete topics. Therefore, it is significant that participants were prepared to willingly change their teaching practices, with the added presence of a coach observer in the classroom. While each participant focused on different year levels, ranges of ability, and topics, their expressed SMART goals were quite similar (see Appendix B).

George explained his modelling of possible ways to think mathematically and problem-solve to meet his students' learning needs during the first interview. He referenced Schoenfeld's (1992) research into mathematical thinking to justify his classroom approach to model alternative ways to read, interpret, and use strategies to solve problems. George described his use of thinking aloud to model deconstruction of a mathematics text, being prepared to "model the back alleys and the dead ends that we're experiencing in that process" (P3, Ind. Int. 1) to demonstrate to students that mathematics requires dynamic thinking and working. His observations of his students, who read a mathematics problem, quickly picked a strategy, then spent the rest of the time trying to make it work, were reflected in Schoenfeld's (1992) findings. In contrast, experienced mathematicians would move back and forth between the problem, using a range of strategies to seek solutions. Schoenfeld (1992) states that mathematics teaching and learning should focus on "seeking solutions, not just memorising procedures; exploring patterns, not just memorising formulas; and formulating conjectures, not just doing exercises" (p. 337).

By the end of the 10-week coaching program, Pete's reflections on the coaching process and his engagement with PL about disciplinary literacy were insightful, in that he made a connection between coaching for PL in order to meet students' learning needs:

> Sometimes we talk about our teaching practice and what we do as teachers, but I think doing this [coaching] is addressing a very specific student need, and I think that is probably a higher level teaching skill. (P4, Ind. Int. 2)

Sally's goal for Year 7 expanded over the course of the coaching phase. The first iteration of her goal was simply: "By the end of Term 1, Year 7 students will independently use the CUBES strategy to read and interpret worded mathematics problems" (P1, Ind. Int. 1). However, after the second observation lesson, Sally discussed ways to include more student academic talk, which reflected the mathematics discourse resources in the shared file. The second part of her goal was

put explicitly. That is, she wanted to "use student-led mathematics discourse to explain their thinking" (P1, RC, 4/3/21). Like Pete, Sally employed a range of classroom pedagogical practices, including the GRR (Fisher & Frey, 2013a, 2013b), and she implemented this with explicit modelling of the CUBES strategy, using think-alouds to verbalise what she was thinking about and particular setting out of her working. Thinking aloud is a form of comprehension strategy that involves periodically pausing and clarifying aspects of texts, which teachers use to support students to monitor their understanding (Baumann et al., 1993). Elish-Piper et al. (2016) employ a coaching strategy called "three levels of think aloud" to assist teachers to make their thinking more explicit for students. Think-alouds support students to learn new processes, and within the Year 7 mathematics classroom, the addition of student-led discourse to Sally's goal reflected the discussion after the first lesson observation, when she discussed changing student pairings in collaborative work to promote mathematics discourse (RC, 18/2/21).

The RC's reflective journal noted Sally was aware that Year 7 students arrive at secondary school from a range of feeder schools, that is, different primary schools, usually within close geographical range of the secondary school (RC, 11/2/21). She also attempted to explicitly model processes to build students' capacity, as alignment at this early stage can support students as they progress to more complex mathematics in the senior years. Sally recalled:

> I want them to be like, "Oh yeah, worded problem, I'm just going to read this and then I'm going to pull out my red pen and my highlighter and I'm going to start pulling apart the question so I know exactly what I am being asked to do." And I just want that to become a way of being for them in maths. (P1, RC, 11/2/21)

To conclude the sub-theme of recognising student learning needs or gaps, Pete shared a significant development with one of his Year 12 Essential Mathematics students. As previously stated, Pete attempted to increase student engagement in order to improve students' independence and confidence. His feedback from a revision lesson was shared via email with the RC (P4, Email 28/3/21), and he was subsequently asked to share his experience with the other participants during the final focus group. Pete revealed that although one of his students dissolved into tears as she attempted to do a worded problem, the fact that she tried to engage with the question and made

several attempts was evidence that a strategy such as CUBES could change student engagement. Pete reflected:

> I think though, that actually shows an engagement as well, like she was trying to wrestle with it. Whereas eight weeks ago, she would have just tuned out straightaway and thought, "This isn't for me." (P4, Focus Group 2)

As evidenced by the teachers' statements, it is clear that participants were able to reflect on their own learning needs as teachers in order to address some of the mathematical literacy learning needs of their students. E. Cox's (2015) paper examined coaching and adult learning, and stated that adult learners use previous experience and seek learning programs such as coaching when they are relevant, or when they need to learn a new way of working to solve a problem. Elish-Piper et al. (2016) outlined six principles of adult learners, which referenced the work of Knowles et al. (2005). In summary, these principles are as follows: (a) adults want to know why they are learning something; (b) they are interested if there is immediate relevance to their work; (c) their learning is problem-centred; (d) they like involvement in planning, evaluation, and implementation of their learning; (e) their experience provides the basis for learning; and (f) they respond best to internal rather than external motivators (Elish-Piper et al., 2016). These aspects resonate with the "learning as experience" to create meaning within the social theory of learning (Lave & Wenger, 1991; Wenger, 1998). Social learning within a trusted community of colleagues and a coach has provided meaning and identity for the four teachers. The literature about adult learning through coaching supports this notion of self-reflection and self-direction as displayed by the participants in this study.

5.3.5 Teacher as Learner: Experimenting

The willingness of the four teachers to be vulnerable underpinned the experimental mindset sub-theme. This resonated with notions of self-efficacy, as they were more likely to embrace a challenge if their self-efficacy was sound. When participating in this educational research project, the teachers modelled the notion of being a learner to their students. While the RC's presence in the participants' classrooms was in the role of observer, Pete invited the RC to share the purpose of the research about coaching and the disciplinary literacy of mathematics with the students in his Year 12 classroom. Furthermore, he stated, "I wasn't very good at maths when

I was at school, so I feel like I've become a better maths teacher because I know what it's like for these kids" (P4, RC, 26/2/21). In this excerpt, Pete is being open with the RC about wanting to keep learning about ways to improve his ability to teach mathematics.

Addressing student confidence at what could be considered a relatively late stage of schooling (Year 12) is an example of Pete's *teacher as learner* experimental mindset. Pete's first goal was to teach Year 12 students to use CUBES as a basic reading and annotating strategy to independently attempt worded problems. In Pete's first individual interview, he identified "some kind of barrier" with his students. This was further expanded upon in an example of how he would typically introduce a problem using a GRR pedagogical approach (Fisher & Frey, 2013a, 2013b). Despite modelling the problem together with the class, then giving a second example for students to work in smaller groups, he stated, "There's still some kind of barrier when they have to individually sit down [and solve the problem]" (P4, Ind. Int 1). When asked about which stage the students showed the most hesitancy at, he noted the last stage when they had to work independently.

Pete could have taken the stance that these students were almost finished with their secondary schooling and that new strategies at this stage could be considered too little, too late. While CUBES was a relatively straightforward process, the aforementioned barriers or blocks to student progress may have been reinforced by years of a lack of mathematical success. Luttenberger et al. (2018) conducted empirical research which acknowledges widespread acceptance that mathematics anxiety is one of the most prominent forms of test and performance anxiety. One of their research findings concluded that a change in instructional approaches can help support student anxiety in the mathematics classroom. Further, the authors contend that a systematic process such as CUBES could be the impetus some students need to overcome reservations and start to achieve independence. Pete's willingness to experiment in his mathematics class was revealed when he noted, "I suspect it's to do with their [students'] comprehension, and being a sciencey person, I just want to control the variables and try something to see if it improves" (P4, Ind. Int. 1). While a strategy such as CUBES, a systematic process for approaching a worded problem, is only one way to approach the issue of mathematics anxiety, Pete's willingness to implement it

in his Year 12 classes reinforced his approach to support student independence, and confirmed his self-efficacy.

Pete devised a quiz for his Year 12 students in order to try and pinpoint gaps in their mathematics learning. His introduction of the CUBES strategy was the result of noting types of student responses, unanswered questions, or misconceptions. This was done prior to the RC's first observation. Once the cycle of observations commenced, and CUBES had been introduced, Pete started noticing an increase in student engagement (RC, 19/3/21). Whereas his early observations were related to a perception about reading comprehension in mathematics, he was now more aware of a lack of confidence when faced with independent problem-solving. Pete reflected that prior to using CUBES, students tried to avoid problem-solving questions, and preferred to engage with questions containing more mathematical notation than words. The RC's reflective journal (RC, 19/3/21) notes Pete's perception that both his Year 12 classes were starting to show higher levels of student participation in the problem-solving questions than previously (before the coaching project). To reinforce that view, Pete noted there were fewer direct appeals to the teacher for help during his Year 12 mathematics classes.

Despite Sally's expressed reticence around her more experienced colleagues (P1, Focus Group 2), her experimental mindset was evident in the Year 7 mathematics classroom. When asked what she would most like her students to be able to do better, Sally indicated, "being confident when doing problem-solving integers" (P1, Ind. Int. 1). Having used CUBES as a strategy in the past, Sally considered it to be a method of introducing systematic reading and annotating for all students to access key information. Mindful of the school's policy that mathematics teachers were expected to implement the QCAA senior problem-solving approach (formulate, solve, evaluate and verify, communicate), from junior (Years 7, 8, 9) to senior (Years 10, 11, 12), Sally taught CUBES to Year 7 students as a preparatory step. She noted: "CUBES doesn't channel them into a certain way of doing things, it's just a strategy to make sure they are interpreting the question" (P1, Ind. Int. 1).

By using feedback provided by the RC, as well as her own observations, Sally showed an experimental mindset in her Year 7 classroom. As the coaching cycles progressed, she expressed a level of uncertainty when she stated:

> I noticed that I felt uncertain in myself and that kind of trepidation trying something new. I noticed I like it though, because it made me reflect, a lot, on what I was doing, because everything was kind of a bit different. (P1, Ind. Int. 2)

Sally's attempts to develop student-led discourse in her Year 7 classroom were in response to small-group collaboration activities. She noticed students kept ideas to themselves, which made her seek other ways to increase participation and social learning (RC, 18/3/21). The tendency for students to withhold ideas is an issue which could be addressed through the notion of joint enterprise (Lave & Wenger, 1991; Wenger, 1998). Sharing processes, routines, and ideas through mathematics talk and discourse practices is a way to bring the benefits of a CoP to students in the mathematics classroom. Sally introduced mixed-ability pairs using a turn-taking activity called Rally Coach, a Kagan Cooperative Learning structure (Kagan, 2007). She trialled different pedagogical approaches and started reading more deeply about mathematical discourse and the benefits for students when developing mathematical thinking and learning to express ideas precisely (NCTM, 2010). By the third classroom observation, after discussions with the RC, Sally devised talking prompts and cues, and provided a vocabulary bank of key terms and phrases to support students with succinct language and ways to ask their partner questions to probe and clarify their understanding (RC, 18/3/21).

The two examples discussed here, that of Pete in the Year 12 classroom and Sally in the Year 7 classroom, provide evidence of self-reflection and the iterative nature of teacher coaching programs. Dobbs et al. (2017) state that teachers need PL opportunities which are embedded within their job and ongoing in nature so they have "time and space to reflect on their learning, particularly with colleagues with whom they can give and receive just-in-time feedback" (p. 29). According to E. Cox (2015), "coaching is presented as the dialectic process that integrates experiences, concepts, and observations to facilitate understanding, provide direction, and support action and integration" (p. 30). Within this cycle of observations and coaching conversations, the teacher's experimental mindset was revealed for Pete and Sally when they changed their classroom instructional practices, based on feedback, to better reflect and support students' needs with regard to the mathematics curriculum.

To summarise the theme of *teacher as learner*, the notion of adult learning principles and a supportive learning culture must be considered. Through a willingness to engage in a CoP and embrace the coaching program, participants developed an

awareness of the disciplinary literacy of mathematics, which translated into changes in their classroom practices to meet students' learning needs.

5.4 Conclusion

The focus of Chapter 5 was on sub-question one, which addressed the types of disciplinary literacy the four participants would regularly draw on when teaching mathematics, and the first key theme, *teacher as learner*. The teachers in the study responded positively to the ideas about disciplinary literacy presented in the first focus group and began to plan and deliver lessons focused on aspects of their learning about the disciplinary literacy of mathematics. Once student engagement began to increase, the teachers were positive and open to more information and experiences to reinforce a disciplinary literacy approach.

Each sub-theme in *teacher as learner* emerged as a result of the four teachers' experiences and their willingness to be vulnerable while participating in a coaching program. The importance of "learning as experience" (Wenger, 1998) and the social processes of practice, meaning, identity, and community were reinforced in this chapter. With an increase in student engagement, participants were motivated to help students better understand aspects of mathematics. Being prepared to teach differently, accepting the presence of a coach in the room conducting observations, and adopting new pedagogical strategies demonstrated how the teachers exemplified "being a learner" in this project.

Educating the teachers about disciplinary literacy practices occurred through a combination of RC-led information and teacher participant collaboration. In the first instance the RC introduced the concept of disciplinary literacy practices through a range of journal articles (see Appendix E) and discussion. It was further explored in focus group discussions as well as individual teacher dialogue with the RC. Learning "how to do it better" (Brouwer et al., 2012, p. 348) evolved from interactions with other members of the CoP, thereby allowing the four teachers and the RC to develop their knowledge together. A digital resource bank was also created for building the shared repertoire of disciplinary literacy practices (see Appendix F).

From this foundation, the four teachers embraced the opportunity to learn more about disciplinary literacy practices that resonated with their context. For example,

Sally and Pete began to investigate mathematical discourse and ways to incorporate social learning through mathematical communication. Pete was able to engage some of his Year 12 students and support their growing independence when attempting worded problems by introducing CUBES as a reading and interpreting strategy.

The second sub-question is addressed in Chapter 6 through the lens of the second key theme, *teacher as guide*.

Chapter 6: Findings and Discussion – Research Sub-Question 2

This chapter furthers the discussion of findings in the previous chapter, by focusing on the second research sub-question in Section 6.1: *How can an early-phase coaching program work to strengthen secondary mathematics teachers' disciplinary literacy learning?* As noted in Chapter 5, data were gathered from mathematics teachers Sally (P1), Harry (P2), George (P3), and Pete (P4), and the RC during the 10-week coaching program at Reservoir State High School.

Findings in Chapter 6 are discussed through the lens of the second key theme, the *teacher as guide*. Section 6.2 explains the importance of vocabulary and developing awareness of mathematics language, as well as the teachers' disciplinary vocabulary. Section 6.3 discusses self-efficacy and collective efficacy as a result of participation in the coaching program.

Table 6.1 outlines the second theme and sub-themes discussed in this chapter.

Table 6.1

Second Key Theme and Sub-Themes

Theme	*Teacher as guide*
Sub-themes	Engaging, challenging, prompting, and cueing
	Giving options
	Providing student collaboration opportunities
	Modelling

6.1 Research Sub-Question 2: *How can an early-phase coaching program work to strengthen secondary mathematics teachers' disciplinary literacy learning?*

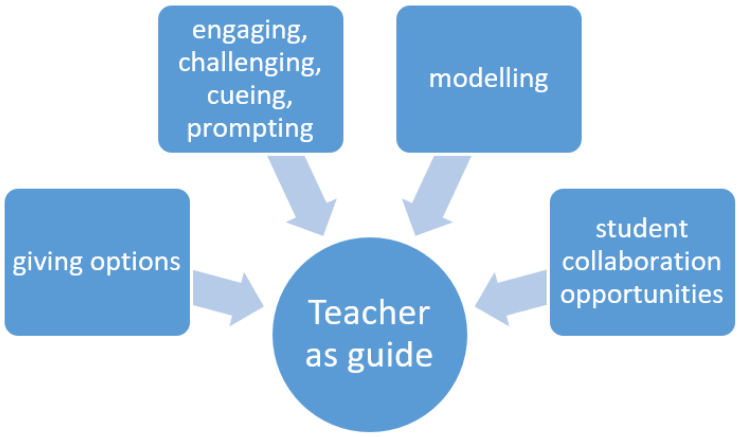
Sub-question two addresses the ways coaching can work to strengthen teachers' learning through a coaching cycle consisting of goal setting, classroom observations, and post-observation coaching conversations. Once the preliminary data collection occurred, the teachers and coach commenced a series of classroom observations and feedback conversations related to the disciplinary literacy aspects of the lesson.

6.1.1 Theme 2: Teacher as Guide

The link between sub-question two and the key theme of *teacher as guide* is the way the teachers started to change some existing classroom practices and began to use different pedagogy. Pedagogical changes were in part due to the introduction of the CUBES strategy (Harry, Pete), the focus on mathematics discourse (Sally), and decisions related to the goal for the project (George). Additionally, the cyclic nature of classroom observations and post-observation coaching conversations meant the teachers' pedagogical decisions were discussed and trialled iteratively. Over the weeks of the coaching program, the RC started to note the presence of the teacher as a guide for students. Pedagogical changes related to disciplinary literacy practices were discussed and reflected on during post-observation conversations. Qualities of the *teacher as guide* theme included engaging, challenging, prompting and cueing; giving options; providing student collaboration opportunities; and modelling. Aspects of each sub-theme are interwoven in excerpts from the data, rather than dealt with as separate entities. Figure 6.1 shows a graphical representation of the *teacher as guide* theme.

Figure 6.1

Theme 2: Teacher as Guide



The language of mathematics became a recurring topic throughout the study, as participants began to foreground vocabulary and key terms more prominently, guiding students more explicitly as a result of their growing awareness of disciplinary literacy. Vocabulary and mathematical language are discussed in more detail in Section 6.2.

Table 6.2 outlines each sub-theme, providing an overview of how each aspect of the *teacher as guide* theme is supported by illustrations of practice.

Table 6.2

Theme and Sub-Themes, Teacher as Guide

Sub-theme	Theme 2: *Teacher as guide* – illustrations of practice
Sub-theme 1: Engaging, challenging, prompting, and cueing	Something is being done to the X. In order to rescue the X, we need to do the opposite. (Pete, RC, 19/2/21) Remember to use the quirk, you know, we need a strong operation to split them apart, to break the marriage. (Pete, RC, 19/2/21)
Sub-theme 2: Giving options	I suppose the pleasing thing from my aspect was that we recently had some maths exams that the kids needed to complete, where the last couple of questions were worded problem-solving type questions. And like physical evidence on their maths paper that they were circling and underlining words and going through what they've, I suppose, done in a note-taking sense to try and unpack that question. (Harry, Ind. Int. 2)
Sub-theme 3: Providing student collaboration opportunities	I think, look, we talked about the identifying and sorting activity that we did, and it would have been really nice to follow up some more on that, but I think you could see that some of the students in those activities kind of were using strategies to talk to each other about what words could mean, or phrases could mean. And what mathematics they could be pointing to and drawing on that inventory that they have to try and make decisions about what it could be, and how they would go about … what maths to apply to the problem. (George, Ind. Int. 2)
Sub-theme 4: Modelling	Probably doing a lot more with the vocabulary straight up, and showing them [students] where it is, and unpacking words and routinely including that with worded problems. (Sally, Ind. Int. 2)

The *teacher as guide* theme is discussed as follows. The first example comes from the RC's observation of George's pedagogy in his Year 8 mathematics classroom. In his main role at the school, George was tasked with the research and development of the school's pedagogical framework, and his knowledge and understanding of teaching and learning enriched discussion and thinking among the participants in the coaching program. Throughout the coaching and observation cycles, providing students with opportunities to collaborate seemed to be a regular component of George's lessons; in this way, his Year 8 classroom environment reflected a CoP, as all three elements of collaboration were present – joint enterprise, mutual engagement, and shared repertoire (Wenger, 1998). The following excerpt from George during his final interview demonstrates aspects of collaboration leading to social learning in the classroom:

> I think, look, we talked about the identifying and sorting activity that we did, and it would have been really nice to follow up some more on that, but I think you could see that some of the students in those activities kind of were using strategies to talk to each other about what words could mean, or phrases could mean. And what mathematics they could be pointing to and drawing on that inventory that they have to try and make decisions about what it could be, and how they would go about … what maths to apply to the problem. (P3, Ind. Int. 2)

This excerpt shows that students used routines and processes to engage in social learning experiences to learn mathematical concepts and skills. For example, they were in mixed-ability groups, using talking prompts to stimulate questioning (RC, 5/3/21).

The RC's reflective journal provided a way of documenting the collaborative aspects of George's lessons. The RC noted the way groups were structured and set up to encourage positive interdependence and shared social regulation of learning (Kagan, 2007). George varied small-group formation depending on the purpose of each activity; for example, some were mixed-ability groupings, while others were homogeneous. The social theory of learning (Lave & Wenger, 1991; Wenger, 1998) places social learning opportunities and practices at the forefront of learning. By providing opportunities for students to work homogeneously at some tasks, or heterogeneously in others, George had introduced a CoP approach to learning. To conduct particular activities, George would show a picture denoting which type of working group was required, that is, homogeneous or heterogeneous. Group types did not directly relate to students' mathematical ability. For example, "transport" was one category denoting mixed-ability groupings; however, the name of each group (trucks, buses, or trains) bore no connection with mathematical ability. Within the same lesson, students would work in pairs with their elbow buddy (adjacent student), then in a transport group, then in an ability group, depending on the task. The RC further noted that "ways of working in groups, i.e., students' roles and duties, have been previously taught" (RC, 5/3/21), as the transition from whole class instruction to smaller working groups seemed practised and timely.

During his first interview George emphasised his focus on pedagogy as follows:

> I might be very good at mathematics. So, if I get up and demonstrate myself doing mathematics, I'm demonstrating the lens of someone who is good at mathematics. Whereas what I need to actually demonstrate is the lens of someone who is trying to get better at learning mathematics. That's the difference between, particularly

> in maths and science, we can see ourselves as subject-matter experts, but an expert is someone who is an expert in what you do. So, a mathematics teacher is supposed to be trying to become an expert at teaching mathematics, not an expert mathematician. (P3, Ind. Int. 1)

Shulman's (1986) PCK can inform understanding about George's attitude towards teaching mathematics. The PCK notion developed by Shulman recognised the integration of subject-matter knowledge, or content, with the pedagogy, or how to teach it. Teaching mathematics using specific pedagogical practices or ways of working within the subject domain assists students to learn new topics. Hill et al. (2008) conducted further PCK research in mathematics to deepen knowledge and understanding in one discipline, and developed additional material to extend Shulman's (1986) work, such as KCS and KCT within PCK (refer to Figure 2.4). The researchers analysed mathematics teaching and types of mathematics problems which occur. George's notion of "trying to become an expert at teaching mathematics" encompasses the challenge for mathematics teachers when content knowledge, knowing students and how they learn, and pedagogy are the foundations of good practice.

In an attempt to provide students with a disciplinary literacy approach to reading and problem-solving, George set a SMART goal (Doran, 1981) which focused on students improving their ability to read and analyse word problems in order to create an equation. Further sub-goals emerged in the first interview, including a desire for his Year 8 mathematics students to be able to read, decode, and articulate a strategy for solving a worded problem, and for students to identify and sort different types of worded problems. The following example encompasses all aspects of the *teacher as guide* theme: engaging, challenging, prompting, and cueing; giving options; providing student collaboration opportunities; and modelling. Despite George's depth and breadth of pedagogical knowledge, and his statements about learning, he embraced the opportunity to develop his knowledge of disciplinary literacy through a coaching approach to PL. Only one of the teacher participants had previously engaged in a coaching approach to PL prior to this study (Sally). Beswick (2014) researched teachers' needs as the focus of their PL, in contrast to the needs of the school, the district, or other agents. Beswick's (2014) findings indicated that access to resources and their uses, and learning new curriculum initiatives, were sought through PL; however, the RC found that while teachers in the study were not exactly sure about

their learning needs, they valued relationships and trust. While teacher learning is a complex and challenging proposition, the relationships, identity, practices, and community aspects of social learning approaches (Lave & Wenger 1991; Wenger, 1998) align with a coaching approach.

Teacher as guide was exemplified in RC observations of George's preparation and delivery of his lessons. Prior to the start of each task, George would model a way to read/interpret worded question types, then support students to discuss and consolidate their ideas. In one activity, students were categorising question types according to key words and operations. Examples of George's questioning prompts were noted in the RC's reflective journal: *What are you looking for in the words of each question? Could this be more than one of the question types? Could you highlight important words in the question to make them more prominent, and could that help you in some way in the future?* (RC, 5/3/21). The RC observed that during the modelling phase, George's pedagogy did not always reflect a smooth and expert process. Rather, at times it appeared that he was making mistakes, getting stuck, and then thinking aloud to demonstrate how the learning process evolves. This modelling by George was noted by the RC, and when brought up in the post-observation conversation, George admitted that he was modelling the iterative nature of working, and prompting students to share their ways of working with their small group or with the whole class. The RC queried George about whether it was his way of supporting students to take risks or to try something different by persevering; he said he wanted students to realise that mathematics inquiry was not a one-size-fits-all or necessarily linear approach (RC, 5/3/21). A set of post-observation coaching question prompts was followed (see Section 5.3.3); however, the qualitative nature of the project allowed for individualised questions and further discussion based upon the lesson.

Post-observation coaching conversations with George consisted of feedback and discussion, with topics such as dialogic instruction, social constructivism, mathematical discourse, and "the jump between reading in maths, interpreting the question, and then applying maths concepts with accuracy and precision" (P3, RC, 5/3/21). Coaching notes revealed the way George used prompts and cues while students worked in groups. For example, George did not tell students *what* to do, preferring instead to provide verbal reminders of *how* to collaborate while attempting each task. He also used debriefing activities with the whole class, eliciting findings from individuals and groups which

demonstrated students' ability to share "out-loud thinking" and student academic talk (RC, 5/3/21). The sharing aloud of thinking resonates with a teaching strategy called "number talks", originally devised by Ruth Parker and Kathy Richardson (Boaler, 2016; Humphreys & Parker, 2015). Number talks encourages students to solve a mathematics problem mentally, then the class shares the different methods and the teacher helps show how they work. Number talks are widely used by mathematics educators, and Boaler (2016) argues that "number talks are the best pedagogical method I know for developing number sense and helping students see the flexible and conceptual nature of math" (p. 50). The shared repertoire and mutual engagement of a CoP were apparent in George's classroom, evident in the way the working groups created their own norms and used shared language and roles to create meaning (Wenger, 1998). For example, after a group activity, the following questions were posed to students in key roles like the lead learner, resource wrangler, task timer, and go-between: *Are there any jobs you found yourselves doing that weren't on our list? Do we need to change anything about roles and responsibilities?* (RC, 5/3/21).

The other three participants also changed to *teacher as guide* at various times throughout the study. This example in a Year 8 classroom shows how Harry adopted the role of a guide by engaging the students with the background and real-world context, modelling a new strategy (CUBES; Twinkl, n.d.), challenging students to work collaboratively, then prompting and cueing students to share their thinking and processing. He also encouraged and rewarded students for finding different ways to elicit an answer. Harry stated this learning objective: "Students will be able to independently read/interpret/create a formula for profit and loss" (RC, 2/3/21). In order to achieve this objective, Harry provided a narrative to explain the background and context for money, along with some applications of profit and loss. In the role of *teacher as guide*, he modelled the CUBES strategy without explicitly naming it. CUBES can be a useful tool for students to use as it provides them with a series of actionable steps to distinguish between and understand each aspect of a worded mathematics problem.

Harry referred to the process of reading and interpreting the problem as finding the "profit recipe" (RC, 2/3/21). He also encouraged students to work in collaborative pairs to derive a formula from their knowledge of key vocabulary (a known definition from a glossary of terms) and the concept of profit and loss. The final question posed to students was, "Can you make a formula for profit and loss?" (RC, 2/3/21). Harry

invited student pairs to share their ideas with the rest of the class, to explain in their own words how they worked out their profit recipe (RC, 2/3/21). During the post-observation coaching conversation, Harry reflected, "I was happy with the way the students were able to determine the profit recipe" (RC, 2/3/21). The link between Harry's guidance and disciplinary literacy learning is the change from his previous way of introducing profit and loss towards using CUBES as a modelled process. From this one lesson segment, Harry embodied the theme of *teacher as guide* in its entirety: engaging, challenging, prompting, and cueing; giving options; providing student collaboration opportunities; and modelling.

The *teacher as guide* theme revealed the participants' willingness to grow their disciplinary literacy in support of their students by learning purposefully. Ippolito et al. (2017) state that the purpose of PL is key; participants must continually reflect on why this work is important and keep that in mind. A socially developed, shared repertoire of disciplinary literacy knowledge emerged from interactions between teachers and the RC. Lachance and Confrey (2003) studied the impact of mathematics teachers "working together as a community" (p. 108) and the way professional communities of teachers are significant for educational reform. Motivated by the learning needs of their students, a collegial structure such as a CoP provides a supportive environment to develop disciplinary literacy learning. As each teacher started developing their goals with the RC and reflecting on their learning, they began to guide their students using disciplinary literacy awareness. Kise (2009) discusses the way experiences can "cause teachers to question their beliefs and make them aware of avenues for further growth" (p. 21). This coaching program provided experiences that suggest the teachers started to strengthen their own disciplinary literacy learning, which then seemed to transfer to their pedagogy and student interactions.

6.2 The Importance of Vocabulary and Mathematics Language

Expanding the participants' developing awareness of mathematical language and the discipline-specific vocabulary that supports greater student understanding in mathematics was an issue frequently raised by participants in the focus groups and during interviews and coaching conversations. It is discussed here to reveal the ways the participants modelled language and processes, foregrounding their awareness of

disciplinary literacy to engage and challenge students and provide them with collaborative opportunities for learning.

During the first focus group, three teachers (Sally, Harry, and Pete) discussed the importance of building the field of mathematical knowledge, developing context and background understanding, and incorporating mathematics vocabulary when introducing new topics in the classroom. As previously noted, George was unable to attend the first focus group. Analysis of data indicated that each participant approached this task differently and that the strategy adopted varied according to the age of the student and the lesson content and/or context of each class. This was evident in the focus group responses when the RC asked if there was a common way that mathematics teachers introduced vocabulary and terms. Pete's response was: "In terms of teaching them literacy? No" (P4, Focus Group 1). Harry further noted, "[There is] mathematical-specific language that you then have to teach and embed with your own work" (P2, Focus Group 1), while Sally discussed how she introduced key terms:

> We have a small section where we go through all the different words used for the operations. But it's just a blip in the textbook type thing. Most people cover it [vocabulary] because it's when you go into expression building for algebra, and they use all those terms. So, you do a quick, "Oh, what are all the other words for adding?" But it's only kind of a once-off, isn't it? (P1, Focus Group 1)

The literature supports the notion that there is a need to develop students' capacity to access and use mathematical vocabulary (Adams, 2003; Doerr & Temple, 2016; Gough, 2007; Quinnell & Carter, 2013). While it may seem that the importance of foregrounding vocabulary and key terms was not consistently approached by the participants, the idea that mathematics language and vocabulary knowledge was critical for student understanding was noted in the RC's reflective journal (RC, 5/2/21). There is also a stance in the literature that the development of a collaboration between literacy experts and subject-area teachers (which in secondary school would be the mathematics, science, and history teachers, for example), could support teachers to develop a disciplinary view of their subject (Temple & Doerr, 2018). Throughout this project, a collaboration unfolded between the RC in the role of the literacy expert and the teachers as mathematics experts.

Meiers and Trevitt (2010) noted that for some students, mathematics texts could seem like a foreign language due to the interplay of symbols, words, numbers,

abbreviations, and spatial elements like diagrams, charts, and tables. Within the discipline of mathematics, some everyday English words become technical terms – for example, the face of a 3D shape, a cliff face, and the face of a person. Other examples like this include the words angle, volume, and rational. Consequently, for some students, worded mathematics questions may seem ambiguous in meaning (Meiers & Trevitt, 2010).

Harry's observation about the nature of senior (Year 11 and 12) mathematics assessment – "It's moving away from numbers on a page to words on a page" (P2, Focus Group 1) – prompted the RC to reflect about whether there *is* a shift away from algorithms with numbers and symbols towards more complex, unfamiliar worded problem-solving questions in assessment tasks. The RC's reflective journal noted:

> Have pre-service maths teaching courses accounted for the need to teach mathematical literacies in a DL [disciplinary literacy] model to account for the perception that there are more words and less numbers? (RC, Focus Group 1)

The RC's reflection about the perception that mathematics could be moving towards worded problems aligned with each participant's stated coaching goals and desire to support students' independence with these tasks. Abedi and Lord (2001) studied the importance of language in word problems in student assessment. While their findings showed students with English language learning needs scored lower than proficient English-speaking students, the ability to perform well in worded problems also depended on the linguistic structure of the question. Deeper analysis and research into the mathematics curriculum could reveal whether Harry's perception is accurate; however, such research was not within the bounds of this study.

6.2.1 Mathematical Discourse

Within classrooms, social activity and language practices foster the development of knowledge which, in turn, underpins student learning. Derived from the work of Foucault (1972), the term *discourse* has been widely used in different contexts. Discourse is employed in this study to encapsulate the social practice of language usage in the mathematics classroom. Discourse aligns with this study's theoretical framework, a social theory of learning (Lave & Wenger, 1991; Wenger, 1998) and the CoP approach. Within the mathematics classroom, the community creates its own routines and ways of working. Students are the apprentices, learning through social

experiences and language. Once mathematical discourse became a focus for Sally and Pete, the participation of each member created social learning opportunities.

At various times during the coaching program, Pete and Sally showed interest in mathematical discourse as a disciplinary literacy teaching approach to enhance student communication in mathematics. Moschkovich (2003) contends that "mathematical Discourse includes not only ways of talking, acting, interacting, thinking, believing, reading, writing but also mathematical values, beliefs, and points of view" (p. 326).

Albeit at an introductory level, the RC developed and shared a resource bank based on topics of interest raised by teachers in coaching conversations (see Appendix F). Directly linked to sub-question two, that is, exploring how an early-phase coaching program can work to strengthen secondary mathematics teachers' disciplinary literacy learning, this provision of specific resources by the RC was a supportive aspect of the coaching program. The resource bank included a compilation of introductory mathematical discourse articles, as mathematical discourse is considered a social learning approach incorporating thinking, language, and communication (NCTM, 2010).

Sally's expressed interest in the topic of mathematical discourse meant she added a language and communication aspect to her original SMART goal part way through the coaching program (see Appendix B for a summary table of the participants' SMART goals). Sally's intention was to encourage more precise language in student-to-student conversations in an attempt to support her students' mathematical cognition (RC, 18/2/21). Ewing (2017) notes that mathematics learners' identities are influenced socially via their classroom experiences and interactions. George's earlier reflection about learning to be a better mathematics teacher (P3, Ind. Int. 1) and Sally's attempts to model mathematical discourse for her younger students are important when considering the influence and potential guidance of the mathematics teacher and the types of social classroom interactions which occur to create meaning and identity for students.

Pete's developing interest in mathematical discourse was to encourage Year 12 students to communicate and work more socially, for example, starting in peer/partner combinations (RC, 26/2/21). While Pete's students were notably conversational and interactive, his goal was to use his growing awareness of mathematics discourse to engage and guide them into mathematical ways of working. Moschkovich's (2003) study of student talk in mathematics identified a continuum of language, from

everyday talk towards more specialist language. This empirical work is relevant when considering Pete's goal for improved communication patterns in the Year 12 Essential Mathematics classroom environment. As Moschkovich (2003, p. 327) notes, "learning mathematics involves, in part, a shift from everyday to a more mathematical and precise use of language". The move towards mathematical language aligns with other literature, particularly the work of Elish-Piper et al. (2016).

Elish-Piper's (2018) framework, disciplinary literacy practices in math, previously discussed in Chapter 2 and represented in Figure 2.3, outlines mathematical habits of thinking, valued texts, habits of practice, and beliefs about mathematical knowledge. In particular, some key framework elements stand out when reflecting on the expressed reading challenges for students in mathematics. Elish-Piper's (2018) framework states that mathematical knowledge is based on convergence, accuracy, reason, and elegance (clarity), and when practising mathematics, precision using appropriate terms is required. It could be argued that there were signs that the coaching collaboration and explicit focus on literacy practices had benefits for the participant teachers, based upon the aforementioned challenges of reading in mathematics and teachers' growing awareness of disciplinary literacies.

As noted in the RC's reflective journal, the mathematics register, or how language is used differently in different circumstances, as a concept resonated with approaches in the Year 12 Essential Mathematics classroom. Within the theme of *teacher as guide*, the sub-theme of engaging, challenging, prompting, and cueing is evident in the following example from Pete's classroom practice, where in the first lesson, the RC was able to observe his tendency to use analogies when explaining operations or new concepts. For example, with reference to algebra, Pete's narrative in the classroom evolved as follows: "Something is being done to the X. In order to rescue the X, we need to do the opposite" (RC, 19/2/21). A second example of this style occurred when Pete was reviewing sine, cosine, and tangent: "Remember to use the quirk, you know, we need a strong operation to split them apart, to break the marriage" (RC, 26/2/21). In light of Pete's expressed concern regarding student engagement and confidence with independent work, the blend of analogy or metaphor with mathematical key terms was indicative of his efforts to prompt student cognition and engagement. The portion of the lesson devoted to pair/partner work was also an opportunity for Pete to support student communication and mathematical discussion and to build their field knowledge, noting more use of key

terms. Moschkovich (2003) contends that "students combine resources from multiple Discourse practices. Students use resources from both everyday and mathematical Discourses to communicate mathematically" (p. 328). This standpoint reinforces Pete's efforts to encourage more student discourse in his mathematics classroom.

In a coaching conversation with Pete, the RC noted the type of everyday narrative he used to provide students with multiple entry points into learning, to guide, cue, and build students' confidence rather than use a lot of specialised or technical explanations. Conversely, when introducing the mnemonic strategy (CUBES) to his class, Pete may have inadvertently dissuaded students from trying it. He used words to the effect of, "I don't particularly like using mnemonics, but you might like them, if so …" (RC, 19/2/21). During the post-observation conversation, the RC suggested using a slightly more neutral approach, such as explaining the purpose of CUBES as a strategy and how it may appeal to different students. This approach could mitigate the possibility of negatively influencing students; if they think their teacher does not like it, they may not invest in the strategy. The post-observation coaching conversation provided the RC with an opportunity to provide feedback and/or to reflect a practice back to Pete to consider. Such reflective practices highlight a benefit of the coaching program to support Pete's PL, for Pete acknowledged the potential influence of his words when introducing the strategy and indicated that in his other Essential Mathematics class he would use a more measured approach (RC, 19/2/21).

Observations in Pete's classroom and coaching conversations with Pete revealed a sense that some students seemed to be more engaged with the language of mathematics problem-solving. In the final focus group, Pete shared the way his Year 12 students would use the CUBES strategy covertly, but not use the annotations (circle, underline, box key words). "They sort of did it mentally, and maybe that was a laziness thing; but they still used all of the concepts from it" (P4, Focus Group 2). When considering Pete's observation about students covertly using CUBES, the RC reflected on whether the Year 12 students felt they were able to interpret worded problems without the need to use annotations once the strategy had been learned and practised. The change in Pete's pedagogy and use of a mnemonic strategy could have stimulated students' self-efficacy and reduced mathematics anxiety by allowing students access to the mathematics concepts. This change in instructional approach to support his

students may have addressed aspects of test anxiety (Luttenberger et al., 2018), thereby helping students to access the information in the worded questions.

Another sub-theme within *teacher as guide* was identified as giving options. Throughout the data collection period, recurring observations and coaching conversations took place. Once the teachers started actively using disciplinary literacy practices in mathematics classes, the notion of giving students options became a pattern in the data. Direct instruction seemed to be less apparent in Sally's Year 7 and Harry's Year 8 classrooms, and opportunities for students to collaborate, discuss their thinking, and share different ways of determining answers started to emerge (RC, 4/3/21). While Harry did not explicitly teach CUBES as a stand-alone strategy, he modelled it when working at the whiteboard. During his final interview, Harry noted the way some students opted to use CUBES when solving worded questions:

> I suppose the pleasing thing from my aspect was that we recently had some maths exams that the kids needed to complete, where the last couple of questions were worded problem-solving type questions. And like physical evidence on their maths paper that they were circling and underlining words and going through what they've, I suppose, done in a note-taking sense to try and unpack that question. (P2, Ind. Int. 2)

After accessing the shared file of mathematical discourse resources, with the aim of supporting Year 7 students to talk about mathematics concepts and processes, Sally stated:

> I think for me just learning about mathematical discourse and how we can support our students to become more confident to talk about mathematics concepts and mathematics processes, and even like being able to describe the skills that they've learnt, has kind of opened a bit of a window and I just want to see more. (P1, Focus Group 2)

Sally considered that the focus on discourse, and the use of mathematics language in the classroom context, would guide students to talk about ideas and improve their grasp of mathematical terms and concepts and their capacity to interrogate each other. By supporting students to develop mathematical discourse skills, Sally was enabling them to expand their ability to learn with their peers, thus increasing their options for mathematical learning. She reflected: "I just want to know more and do more; it was only a limited foray into that area and it's something that I think I enjoy" (P1, Focus

Group 2). Within the domain of mathematical PCK, Hill et al. (2008) categorise KCS as a way of teachers knowing about their students and knowing about mathematics. Sally's growing interest in mathematical discourse to support her Year 7 students to better understand and discuss mathematics concepts aligns with this aspect of the diagram (see Figure 2.4, Domain Map for Mathematical Knowledge for Teaching, Hill et al., 2008).

The final aspect of mathematical discourse relates to Harry and an acknowledgement in the final focus group about how the study changed his approach and set-up for problem-solving in the classroom. During the first focus group session, Harry indicated that his usual practice was focused on how to "unpack the maths" and make it relevant for students. What Harry was referring to is KCT, which in the Hill et al. (2008) figure is a subset of PCK. Harry's knowledge about teaching and mathematics includes decisions about how to sequence instruction to support student understanding of the language of mathematics. Following his involvement in the coaching program, Harry revealed a shift in his KCT thinking with this approach:

> Going into a problem-solving lesson now it's "How am I going to make the language accessible for the kids?" I think maybe just like a shift in the way that I thought about what a problem-solving lesson looked like, maybe starting with the language first and the maths second is, I suppose, the shift that I made in my mind. (P2, Focus Group 2)

The notion of access to language is important. Harry's attempt to make language accessible for his students is reflected in the literature on LPP (Lave & Wenger, 1991) and in the idea that a beginner or learner moves from the outside (periphery) to the centre of a community through active social engagement and learning. Through social interaction in a CoP (classroom), students gain access to the practices and identities of the group.

Kise's (2009) differentiated coaching approach for teacher PL states that changes in teaching practice are more likely to occur with information and evidence about how students learn, and that meeting individual teachers' learning needs can happen through coaching. While not every teacher has the same PL needs, the flexibility and trusted relationship between a coach and coachee may provide more valuable and timely support to change classroom practices. During the first focus group, Harry directly asked the RC this question: "What do I need to know to teach disciplinary literacy? I'll admit I've got almost no idea about it" (P2, Focus Group 1).

Harry's thinking about pedagogy and teaching practices to support his students' access to mathematical language in the previous excerpt exemplify the way his identity had begun to change while within a community of disciplinary literacy learners. This could also be due to the differentiated nature of coaching and his trust in the early-phase coaching program.

The intent behind a focus on mathematical discourse in this section was to reinforce the ongoing nature of PL. A key finding from Beswick's (2014) study into PL for mathematics teachers was the importance of respecting teachers' professional identities as competent practitioners. Coaching is an ongoing, timely, and relational practice which can support PL and sustained change for individual teachers. In the first focus group when asked what disciplinary literacies teachers draw on when teaching mathematics, participants acknowledged the existence of discipline-specific vocabulary and mathematics language. However, by the end of the coaching program, the teachers were more aware of its importance. From the outset, Sally's earlier statement about covering key terms as "a blip in the textbook" (P1, Focus Group 1) contrasted with modelling discourse practices with students and sharing her changed practices with other participants as a result of the coaching program. She shared the way she had changed her approach to a new topic of learning: "Probably doing a lot more with the vocabulary straight up, and showing them [students] where it is, and unpacking words and routinely including that with worded problems" (P1, Ind. Int. 2).

While it has been documented in the literature that secondary teachers may not have experienced learning about disciplinary literacies either in pre-service courses or in-service training (Fang, 2014; Ippolito et al., 2017), this coaching program has provided participants with the opportunity to collaborate and develop self-efficacy as a result of learning new disciplinary literacy practices. Elish-Piper et al. (2016) outline strategies for large-group coaching, small-group coaching, and individual teacher coaching. The researchers recommend that all disciplinary literacy coaching programs start with goal setting, include teacher input to determine the level of required support, have a cycle of coaching activity, and summarise progress with coaching conversations to review the goal. Regardless of the level of coaching interaction, the value of one-to-one, individualised PL with a coach can support secondary mathematics teachers to strengthen their disciplinary literacy knowledge.

6.3 Self-Efficacy and Collective Efficacy

The development of teachers' self-efficacy and collective efficacy is addressed in order to continue discussion about the second sub-question: *How can an early-phase coaching program work to strengthen secondary mathematics teachers' disciplinary literacy learning?* In Chapter 2, a potential connection was made between self-efficacy and literacy learning for secondary mathematics teachers. Fang (2014) and Ippolito et al. (2017) describe the negative impact on secondary teachers' confidence to teach mathematics using the literacies of the discipline if they have not received explicit disciplinary literacy instruction as part of their pre-service or in-service training. Additionally, it could conceivably be the case that without adequate development of disciplinary literacy learning in mathematics, some mathematics teachers' knowledge of PCK (Shulman, 1986) may also be under-developed. Conversely, efficacy may be positively influenced if a teacher perceives their performance is successful (M. Tschannen-Moran & Hoy, 2007). The literature notes that teacher efficacy is linked to student outcomes, which in turn influences the amount of effort and perseverance teachers invest (M. Tschannen-Moran & Hoy, 2001). Fang (2014) further states that along with specific content, each subject area has "their own characteristic language forms and hence distinctive literacy practices" (p. 446). The analysis of data obtained in this research study also indicates that by engaging with coaching, the participating mathematics teachers began to expand their focus by including disciplinary literacy instruction in addition to mathematical content. This notion of content knowledge as well as disciplinary literacy knowledge was previously discussed in Chapter 2 as teaching and learning on the diagonal (see Figure 2.2). Di Domenico (2014) contends that "in order to implement disciplinary literacy practices effectively, teachers need to be able to teach on the diagonal" (p. 4). This change in focus was a notable shift from their original teaching approach, which was directed toward the singular objective of teaching mathematics concepts or content.

Pete provided some interesting insights into his PL and development of self-efficacy as a result of this coaching project. Previous discussions with colleagues around perceived gaps in student learning but not knowing what to do next meant he was open to learning about disciplinary literacy. Pete's willingness to join this research project as a participant was clear when he said, "I was on board from the start, because there was

already a conversation that I'd been having sort of informally with Harry especially, and some other mathematics staff who teach the same subjects" (P4, Ind. Int. 2).

The work of Bandura (1977a, 1977b, 1982, 2000, 2001) and his study of self-efficacy and collective efficacy resonates with Pete's willingness to embrace change through coaching. Bandura's (1977a) explanation of poor self-efficacy as a result of unsuccessful experiences means that the positive impact of a coaching program on teachers' sense of self-efficacy is significant. A positive perception of the coaching program to support and enhance disciplinary literacy learning at the individual level could also boost the collective efficacy of a teaching team. Bandura's (2001) notion of collective efficacy, that is, the collective power of a group relies on members' shared beliefs as well as individual efficacy, could be another potential outcome of this project.

Although the 10-week project provided a limited amount of time for participants to engage with the scope and depth of disciplinary literacies in mathematics, Pete's response in the final individual interview demonstrated a growing sense of agency. This is evident in his comment, "Next time I identify blocks in learning, maybe I'll go and do the research myself" (P4, Ind. Int. 2). Pete's self-efficacy, that is, his ability to regulate actions and responses, to persevere and rise to a challenge, is also demonstrated in this statement.

6.4 Conclusion

This chapter has presented the findings and discussion related to the second research sub-question, *How can an early-phase coaching program work to strengthen secondary mathematics teachers' disciplinary literacy learning?* In particular, it examined the second key theme linked to an investigation into how early-phase coaching can influence secondary mathematics teachers' disciplinary literacy learning. Through the theme of *teacher as guide,* the chapter discussed the ways in which four teachers who engaged in coaching to develop an awareness of the disciplinary literacies of mathematics were able to apply new discipline-specific pedagogical practices to support gaps in their own and their students' learning.

The significant findings included, first, that teachers valued the time to discuss their work as it related to student need; second, when student engagement increased, teachers were more positive about changing their pedagogy and practices; third, the

participants were highly motivated to support students to improve their ability to read and interpret worded problems; and fourth, teachers in the study were open to collegial observation and feedback. Findings also indicated that the impetus for individual teachers to conduct independent research in the future was an important part of the development of their self-efficacy and, while not the focus, provided a useful outcome.

Dobbs et al. (2017) note the challenge of adolescent literacy at the core of disciplinary literacy coaching. Not only do secondary mathematics teachers have to plan and teach their content, but they must plan and deliver the literacy skills inherent in the discipline. The coaching program sparked much discussion about the language of mathematics and the disciplinary literacy of mathematics. Shulman's (1986) PCK and its revised model, the domain map for mathematical knowledge for teaching (Hill et al., 2008), informed the discussion about KCT, KCS, and how disciplinary literacies are an integral connection for learning within the discipline of mathematics.

The next chapter continues to convey the study's findings and discussion with reference to the third research sub-question, and includes a focus on the third key theme identified in the data analysis. The theoretical framework of the study is also discussed in relation to the coaching program.

Chapter 7: Findings and Discussion – Research Sub-Question 3

The previous chapter addressed sub-question two and the sub-theme of *teacher as guide*. Chapter 7 focuses on sub-question three, namely, *How does an early-phase coaching program contribute to mathematics teachers' disciplinary literacy learning?* Through the third key theme of *teacher as collaborator*, insights gleaned from the CoP approach (Lave & Wenger, 1991; Wenger, 1998) are discussed. Using the social theory of learning as the theoretical framework (Lave & Wenger, 1991; Wenger, 1998), the collaborative nature of this theme provides insight into the opportunities for the four participating teachers and the RC to interact and develop a growing awareness of the disciplinary literacies of mathematics.

The analysis and discussion of findings in Chapter 7 includes data from the final semi-structured focus group and the final individual semi-structured interviews. Analysis of data from the RC's reflective journal is also included to provide further insight to the analysis and discussion of how a coaching program can contribute to the four participating teachers' disciplinary literacy learning. The chapter is structured as follows: in Section 7.1, the theme of *teacher as collaborator* reveals the importance of collaboration between teachers and a coach to influence disciplinary literacy learning. Three sub-themes are discussed and excerpts from focus groups, interviews, and the RC's reflective journal provide evidence to support sub- question three. Aspects of a social theory of learning (Lave & Wenger, 1991; Wenger, 1998) have been interwoven throughout the findings and discussion, and Section 7.2 reflects on the importance of this theoretical framework and CoP approach.

7.1 Research Sub-Question 3: *How does an early-phase coaching program contribute to mathematics teachers' disciplinary literacy learning?*

7.1.1 Theme 3: Teacher as Collaborator

The *teacher as collaborator* theme was identified towards the end of the data collection phase. The term collaborator is used in this study to reflect the opportunity for participants to share practices and experiences with each other and to reflect on others' ideas. Each interaction between a participant and the RC aligns with this description of collaboration, as well as the focus group sessions with four (three

teachers and the RC) or five (four teachers and the RC) members. Thematic analysis using Braun and Clarke's (2006) inductive thematic coding process revealed a theme the RC initially named "teacher as expert", particularly in the first round of data collection when the mathematics teachers were sharing their practices. By continuing to review the data and refine the analysis through the lens of the RC, it became apparent the "expert" descriptor was not an accurate representation of the patterns in the data related to disciplinary literacy awareness. Rather, through continued analysis of the transcripts and reflective journal notes, the recurring themes and patterns reflected the notion of collaboration. Accordingly, the third theme was ultimately decided: *teacher as collaborator*.

Aspects of this theme include the notion of collegial engagement; being supportive of and feeling validated by colleagues; and advocating for a coaching approach in schools. Elements of this theme were intertwined with the first two themes, *teacher as learner* and *teacher as guide.* At times, it was challenging for the RC to isolate specific examples due to the complex intersection of coaching, teaching, and learning. The social theory of learning (Lave & Wenger, 1991; Wenger, 1998) and its key idea of CoPs are woven throughout the findings and discussion through the lens of *teacher as collaborator* in this chapter. Figure 7.1 represents the concept of theme three, *teacher as collaborator*.

Figure 7.1

Theme 3: Teacher as Collaborator

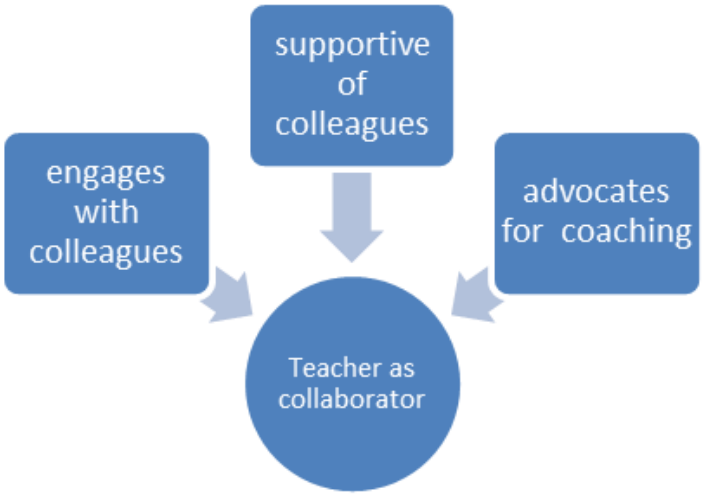


Table 7.1 outlines the theme and sub-themes of the *teacher as collaborator*.

Table 7.1

Theme and Sub-Themes, Teacher as Collaborator

Sub-theme	Theme 3: *Teacher as collaborator* – illustrations of practice
Sub-theme 1: Engages with colleagues	I'd like to think that it [collaboration] could just be tied into our general meetings. (Pete, Focus Group 2)
Sub-theme 2: Supportive of colleagues	Trust I suppose is the big thing. Because only then are you willing to try things that are new and that you don't know how it's going to go. (George, Ind. Int. 2) Sometimes you're doing many good things, and again, it's just that you don't have someone to point that out to you, or it takes someone to place a label on that thing. So that you can be aware of your strengths and opportunities, if that makes sense. (George, Ind. Int. 2)
Sub-theme 3: Advocates for coaching	I think that the more we can talk about this [disciplinary literacy] as a maths faculty the better, and coaching can be a part of that kind of conversation, about how we talk about maths, how we get kids to talk about maths. (Sally, Focus Group 2) Well I think there's a big opportunity for coaching here because like you said, people come out of university with different levels of skills. (Sally, Focus Group 2)

7.1.1.1 *Teacher as Collaborator*: Engages With Colleagues

Throughout the coaching program, and as part of the RC/coachee interactions, participants expressed a positive perception of collegial engagement opportunities and of coaching as a form of teacher PL (P1, P2, P3, P4, Focus Group 2). In presenting the analysis for the *teacher as collaborator* theme, the work of Kise (2009) is useful. Kise identifies collaboration for teams of teachers at three levels: I, superficial; II, segmented; and III, instructional collaboration. Kise (2009) asserts that Level III (instructional collaboration) emphasises the importance of professional autonomy, with teachers able to remain open to ideas and feedback and to harness their own and others' strengths. Following the analysis of data, the RC determined it was the third level of deep, instructional collaboration in Kise's (2009) schema that consistently occurred during the coaching program, which was significant for this research project. As a CoP, the participating teachers worked together and engaged in teaching and learning conversations, while sharing ideas and resources (RC, 1/5/21). Participants began to develop a culture of disciplinary literacy learning by demonstrating mutual support and engagement, feeling validated by colleagues; embracing the role of coachee; and expressing support for a coaching approach in schools. The essential elements of a CoP,

joint enterprise, mutual engagement, and shared repertoire (Wenger, 1998) were evident throughout the study. For example, the mathematics teachers were engaged in a coaching program with a focus on mathematics disciplinary literacy learning, which provided a shared domain of interest where the exchange of information and ideas, and learning about disciplinary literacy, occurred socially with trusted colleagues.

The recent focus on collaboration and coaching in Queensland DoE publications (DoE, 2021a, 2021b) reinforces collegial engagement and classroom coaching as effective PL approaches for teachers and school leaders. While Reservoir State High School had one pedagogy coach working in the school at the time of the research project, a widespread and systematic program of coaching for teacher PL had not yet occurred. Participants referred to collaboration when planning units of work; for example, in the final interview, Harry noted the way he was already talking to a colleague, the Year 8 mathematics coordinator, to influence planning for the upcoming problem-solving unit. Harry shared this information to indicate how his thinking and pedagogy had changed as a result of the coaching program to influence disciplinary literacy learning.

As previously discussed in Chapter 2, and reflected in this study's findings, the positive impact of coaching as embedded, ongoing PL for teachers has been noted both in Australia (Gill et al., 2010; Lynch & Madden, 2015; van Leent & Exley, 2013) and overseas (Bengo, 2016; Ferguson, 2014; Howe & Barry, 2014; Kraft & Blazar, 2017). Coaching is also promoted by the DoE as a core component of leadership strategy, which in the future could positively influence the way schools are staffed to include their own site-specific coaches. The state schools' staffing model (DETE, 2013a) does not include a separate classification for teacher educator roles such as coaches. Principals may use allocated Investing for Success funding "to support students to achieve improved outcomes across all stages of schooling" (DoE, 2021a, para. 1) by creating a coaching role or by innovating through staffing allocations to create school-funded coaches (DoE, 2021a).

Pete expressed the way he felt about collaboration and how it could be incorporated more readily to support teachers. Along with preparing lessons and resources for teaching and learning, teachers are required to attend weekly staff meetings in most schools. Pete noted: "I'd like to think that it [collaboration] could just be tied into our general meetings" (P4, Focus Group 2). Pete's statement echoes the benefits of

collaboration as part of meetings so that time spent with colleagues could be focused not just on content and assessment tasks, but on sharing practices to improve pedagogy. Sally stated her support for collaborative approaches between experienced, senior colleagues and those teaching out-of-field when she said, "I think the opportunity [collaboration] would be for them to help coach us who are out-of-field, which is many mathematics teachers, which would really unify us" (P1, Ind. Int. 2).

7.1.1.2 *Teacher as Collaborator*: Supportive of Colleagues

The *teacher as collaborator* theme was drawn from the thematic coding process. One aspect of *teacher as collaborator* that became evident in the final focus group discussion and individual interviews was the notion that teachers in the study felt validated and supported by their colleagues. Within a CoP this is known as mutual engagement, and in this study relationships and a sense of community were created by participants engaged in learning about the disciplinary literacies of mathematics (Wenger, 1998). Throughout the project, the feeling of being in a partnership resonated for the teachers and the RC. For example, Sally felt that coaching was for "anybody who wants to up [improve] their skill level and just get better" (P1, Ind. Int. 2). George was able to identify the benefits of having trust in the RC and, "being willing to try things that are new and that you don't know how it's going to go" (P3. Ind. Int 2). In the capacity of RC, it was a privilege to build the overall project while being an active participant and learner in the case study. Notes in the RC's reflective journal (May 2021) summarised the way the coaching program was perceived as a stimulus for teachers and the RC to try new ways of working. The RC noted that it was more powerful if teachers had identified a need to support a gap in their students' learning. This was expressed by Pete when he noted:

> Sometimes we talk about our teaching practice and what we do as teachers, but I think doing this [coaching] is addressing a very specific student need. I think that is probably a higher level teaching skill: to be able to assess exactly what's going on with your learners and then tailoring your teaching to suit those learners. (P4, Ind. Int. 2)

As such, support and validation of participants were key aspects of the process, experienced by the RC and the teachers through social learning opportunities.

From the disciplinary literacy coaching perspective, social learning and collaboration are integral aspects of teacher PL. Previously referred to in Section 4.3.1, Elish-Piper et al.'s (2016) eight guidelines for effective disciplinary literacy coaching (see Appendix A) include two which are relevant for this study. Guideline number five emphasises that the coach should be situated "as a collaborator, not an expert" (p. 17), and in noting the variety of subjects derived from the disciplines at secondary school level, Elish-Piper et al. (2016) acknowledge it would be unrealistic to expect one coach to be an expert in every discipline. The link between this guideline and the current study is reflected in the coaching role, for the RC had not received preparation for and practice in teaching mathematics. However, the RC is an experienced literacy coach and secondary teacher. Moreover, in working with and researching the practice of the four mathematics teachers participating in the coaching program, the RC has drawn from researcher positionality. In this capacity, the RC has collaboratively shared guidelines and strategies with the teachers to assist in their development of disciplinary literacy in mathematics.

The second guideline from Elish-Piper et al. (2016) that is significant for this study is guideline six. It states, "let collaboration develop" (p. 17), indicating that the coach and teachers need to be patient and harness the capacity to listen carefully to each other. Respectful listening and collaboration also enable a coach to help teachers unlock and realise their own potential by providing constructive feedback. This focus assists teachers in working with their coaches and fellow colleagues to deepen their knowledge and understanding of the disciplinary literacies required to improve their learning. A coaching research project conducted by van Leent and Exley (2013) found that coaches cannot be expected to be experts in every discipline, as they only have so much capacity. Coaching models must account for this; for example, a coach may have extended networks or access to outside facilitators such as academics to provide further expertise to support coaching activity.

Other opportunities for participants to collaborate and provide validation and support arose during post-observation conversations, in focus group discussions, and during individual interviews. The presence of the RC as the classroom observer was ongoing during data collection in Term 1, and 10 classroom observations were conducted. The RC visited each participant's classrooms to observe their disciplinary literacy instruction, and post-observation conversations were a consistent aspect of the

coaching program. For example, specific questions would be routinely asked during the post-observation coaching conversations to encourage the coachee (teacher) to reflect and respond on their experiences in the lesson. Further clarifying and probing questions elicited greater depth to participant responses. These questions (see Section 5.3.3) are restated here:

- *How did the disciplinary literacy component of the lesson go today?*
- *What worked well? What else? And what else?*
- *What would you change? Why?*
- *What would that look like?*
- *What will you do next week?*
- *What do you need from me? How can we work together?*

By asking such questions during the post-observation conversation, the RC was able to prompt teacher reflective practice in a collaborative context. Such collaboration was integral to positioning the RC as a supportive colleague for the participants. The spotlight paper (EIRC, 2021b) states, "In education, coaching helps teachers transfer newly learnt skills into their pedagogical repertoire. Research shows that coaching can have a powerful impact on the implementation of new teaching approaches" (p. 3). By conducting post-observation discussion based on the question prompts, focus was consistently on the new disciplinary literacy aspects and the teachers' perceptions of their changing pedagogy. The consistent format for questioning was part of the coaching program to support each teacher to reflect on their pedagogy and the lesson's disciplinary literacy focus, thus providing the teacher with timely feedback to support and enact change over time.

Sally shared how the presence of the RC encouraged her to put things into practice and the way having a coach in the room made her feel accountable. She noted "the accountability of having someone coming to observe, and that reflection process" (P1, Focus Group 2). Harry's response about collaboration and support from the RC indicated a sense of the coach as enabler when he stated, "I'd say it's probably for me just the formalisation of picking an approach … 'This is what you're going to do, it's only this and we're just going to focus on this'; it was probably the best part of the program" (P2, Focus Group 2). Note that Harry is expressing his own thinking about selecting a particular approach to disciplinary literacy learning. At no time did the RC actually say,

"This is what you're going to do." George's reflection during the final individual interview showed how he valued the presence of the RC to support his PL:

> Sometimes you're doing many good things, and again, it's just that you don't have someone to point that out to you, or it takes someone to place a label on that thing. So that you can be aware of your strengths and opportunities, if that makes sense. (P3, Ind. Int. 2)

Participant collaboration during focus groups was another aspect of collegial support. In Sally's final interview, when asked how she felt about hearing her colleagues talk about their coaching experiences and disciplinary literacy practices in the focus group, she reflected: "It was good, I really enjoy listening to others and gaining other peoples' perspectives" (P1, Ind. Int. 2). The RC's journal (31/3/21) noted the way some participants acknowledged each other's ideas during the final focus group, which was conducted via Zoom. Although the online mode meant more stilted and less conversational interactions, participants took turns to provide answers and then indicated their responses to their colleagues' comments by nodding or affirming others' experiences. For example, Sally said, "Yes I agree with what Harry said about the coach being a shortcut to good resources" (P1, Focus Group 2), and Harry noted, "I think what Sally said is really accurate, and …" (P2, Focus Group 2). These exchanges demonstrated the importance of providing opportunities to share experiences with colleagues to increase the likelihood of joint enterprise and shared repertoire, particularly when engaging with an improvement focus like disciplinary literacy learning through a coaching approach.

The literature on CoPs provides insight into the types of meaningful interactions that occur when participants with a diverse range of teaching experience and expertise collaborate in a disciplinary literacy CoP (Gellert, 2013; Mistretta, 2012; Rawding, 2013). During the first interview, Sally stated she was relatively inexperienced as a teacher; however, her early sharing of the CUBES strategy (Twinkl, n.d.) in the first focus group sparked a cycle of explicit teaching of this strategy for Harry, teaching Year 8, and Pete, teaching Year 12. Between them, participants in this study had a range of teaching experience: Sally had the least years of experience with 6 years, Harry had 15 years of teaching, George had taught for 16 years, while Pete had been teaching for 18 years. Lave and Wenger (1991) found the benefits of productive social learning in a CoP were relevant for both early-career and more experienced teachers.

Within a small teaching team, recognising each person's capacity and talent, whether a novice or more experienced teacher, can influence the effectiveness of the CoP (Rawding, 2013). Wenger's (1998) notion of a CoP was evidenced in this study, as the participants supported each other through collegial interaction, sharing of resources and ideas, or offering to help with related issues in the mathematics classroom.

The theme of *teacher as collaborator* and the sub-theme *supportive of colleagues* align with the view that a coaching program can provide mathematics teachers with trusted relationships and quality information, and support teachers to align their teaching identity with a disciplinary literacy approach. Within the social theory of learning, Wenger (1998) contends that "learning as becoming" forms a person's identity. Joint enterprise is typified by shared processes, routines, and language, which for the participating mathematics teachers, encompassed the disciplinary literacies of mathematics and changes in classroom pedagogies. Pete's observation in the second focus group about aspects of the coaching program that contributed to disciplinary literacy learning encapsulated some of his PL. He noted that when compared with his previous casual staffroom conversations with colleagues, his involvement in the coaching program prompted a more professional coaching conversation supported by research and some expertise (P4, Focus Group 2).

The *supportive of colleagues* sub-theme was evident in the RC's observations of how participation in the coaching program helped Sally to re-engage with planning and pedagogy to support her disciplinary literacy learning. Sally also noted the benefits of setting herself a student-focused coaching goal:

> It really reminded me of the importance of chunking all your tasks when you're trying to achieve a big goal. Because it sharpened me up again. I had to get faster at what I was doing because I was trying to do more … so running at that higher level where I'm having to push myself. It was good because I was so out of my comfort zone to start with. (P1, Ind. Int. 2)

Sally's statement that at times she was challenged by change, and out of her comfort zone, prompted the RC to reflect on ways to support teachers (RC, 31/3/21). One aim of this study was to foster trust and provide quality information in the form of resources and time through the implementation of the coaching program. It was anticipated the program would provide opportunities for participants' PL through collaboration with the RC and each other.

This study's findings reflected the aspect of a CoP called LPP (Lave & Wenger, 1991), where members of a community start to take on the identity and practices of the group. Sally's growing awareness of mathematics discourse and ways to incorporate this aspect of disciplinary literacy into her Year 7 classroom was previously discussed in Section 6.2.1; however, her students' learning needs were the impetus for her own PL. She stated, "It's something that I've just become so aware of. Making sure I'm very precise in my language and really coaching my kids to use the right words at the right times" (P1, Focus Group 2). Sally observed that changes in her students' ability to incorporate aspects of mathematics discourse in classroom discussions as a result of the coaching program were noticeable: "They have a grasp of the mathematical language and they can kind of interrogate each other" (P1, Focus Group 2). Sally was noticing the change in students' identity as mathematics learners formed within the CoP in the Year 7 classroom. Pete acknowledged Sally's observations and added, "What Sally was saying is exactly what my thoughts were, like having a common language to share with the kids" (P4, Focus Group 2). The elements of communication, language, and increased engagement as described by Pete and Sally in these examples resonate with LPP (Lave & Wenger, 1991): membership within the classroom context, with shared identity and practices between students, and the CoP aspects shared between the teacher and students.

The coaching literature provides other insights into the significance of developing positive relationships in school-based coaching programs. Boyd (2008) outlines the need for a reflective practice culture in schools and the willing participation of the coachee. Quality relationships are equally as important as knowledge and skill because a coaching program relies on two-way communication and the ability for both coach and coachee to reflect on professional practice. As the research study coaching program developed, Sally indicated she found the observations to be a positive experience when she stated:

> It's one thing to kind of have a think about it and get some ideas [about disciplinary literacy], but if someone's coming to watch you do it you become a lot more, like, I don't know, like you really want to put it into practice to kind of have that whole loop happen. So, then you can continue to grow. I just find that the observations are really good for me. (P1, Focus Group 2)

Sally's quote demonstrates a positive connection between the coaching program, with its inbuilt feedback loop, and her PL. Elish-Piper et al. (2016) refer to this type of

coaching as a teacher-initiated model, where the teacher and coach discuss and set goals, then engage in classroom observations followed by feedback discussions. Elish-Piper et al. (2016) note that in this method of coaching the teacher generally shows a significant level of internal motivation and interacts with the belief that a coaching program will support them to learn and meet the challenges of their students' learning.

All four participants in this study embraced the opportunity to develop professionally through coaching observations and post-observation discussion. Harry's views about the presence of other people in his classroom were shared during the first focus group:

> I'm of the belief that if you have people in your classroom watching you work, no matter whether it's a coach, a pre-service teacher, you are just on show, you are better at your game than if you are not on show. For me it's like a step-up type of thing, so that's the buy-in for me, I think. (P2, Focus Group 1)

Pete agreed with Harry's stance about having people in his classroom, and to foster collegial support, he would sometimes offer to go into new teachers' rooms, for example, as an extra set of hands. Pete emphasised that:

> We have a lot of new teachers, and so I've just kind of said, "Hey, you know just informally, do you mind if I wander past and just spend half an hour in your room?" And new teachers are like, "Oh, yes please, that would be great." Mostly just to make them feel part of the team. (P4, Focus Group 1)

Pete's offer of collegial support exemplifies the *teacher as collaborator* theme in this example. His actions as an emerging teacher educator show support and validation for new teachers, helping them to form the identity of a mathematics teacher through social interaction within an informal CoP at the school.

Recognition of the importance of quality teacher PL as evidence-based, sustained, collaborative, and responsive to specific school contexts resonated with the disciplinary literacy coaching program at the heart of this project. Clemans et al. (2010) researched school-specific teacher PL programs involving primary and secondary teachers with varying levels of teaching experience. Ongoing learning for teacher professionals is not just about upskilling; it incorporates authentic change and recognises the value and impact of teacher expertise on student learning outcomes. A key finding of the Clemans et al. (2010) study related to insights around identity for teacher educators, most of whom had to transition from a teacher colleague to an

educational leader in their school setting. In many schools the coach role would be fulfilled by an experienced teacher/colleague with strong relational skills (Boyd, 2008). Other coaching programs such as peer coaching, where colleagues observe each other's practice (Showers & Joyce, 1996), could support PL needs. Pete's willingness to go into newer colleagues' classrooms as a supportive presence prior to this study reinforces the value of a more experienced teacher leader collaborating to share repertoire and build knowledge and skills (Wenger, 1998).

Due to his school-wide role as a pedagogy leader and teacher educator, George experienced open classrooms and invited teachers to observe a range of pedagogical practices. Despite being somewhat time-poor due to broader school duties in his teacher-educator role, George valued working with a coach to focus on student collaboration and social learning opportunities with his Year 8 students. In his final interview, George noted the way his students had engaged when he said:

> I was actually encouraged at the end of the term when we did that activity with the problem-solving question before the assessment. That I felt like, you know, there were a good number of responses; students were able to point to things they were relying on or thinking about in order to make decisions about what mathematics to apply. (P3, Ind. Int. 2)

During the coaching program, the RC set up a 2-week observation cycle to better align with his availability. Once George had established a starting point and some baseline data, he was interested in using specific pedagogical strategies to strengthen students' ability to accurately identify types of mathematics questions. To provide individual coaching support, the weekly model was adapted to suit George's needs:

> I think what would be really good is if I went away and fleshed out the idea, and had a touch base with you before I used it. And then have you in to watch it happen. And I can go away and do the data parts, get a sense of the student data and know your learners, and then maybe you come and watch it happen. (P3, Ind. Int. 1)

During the final focus group (Week 10), which occurred via Zoom due to a sudden statewide lockdown in response to COVID-19, the RC asked participants about aspects of the coaching program that contributed most to their disciplinary literacy learning. George noted support via the benefit of time to discuss his work with a colleague when dealing with competing agendas like unit outlines, curriculum, and

school processes, stating, “It was almost like I had permission to put time aside … you can feel a little bit torn …” (P3, Focus Group 2). George also stated the benefits of coaching which could be provided by peers: “I think having peer coaches who are trained in coaching who may not be school leaders as well is another really powerful thing that can be done” (P3, Ind. Int. 2). It is notable that George’s observations align with the literature on coaching to effect change in educational settings (Elish-Piper et al., 2016. When coaches support teachers to reflect on classroom practices, and work with teachers to set goals which benefit students, the outcomes can be beneficial.

Fullan and Knight (2011) state that without coaching to support educational change initiatives, reforms may not become embedded or support real improvement. Additionally, Fullan and Knight contend that system-wide approaches to sustainable improvement are more effective at changing practices – for example, implementing coaching across a sector with multiple schools instead of individually (Ferguson, 2014). Integral to improved student outcomes across a sector was the involvement of school principals with coaches and school leaders (Fullen & Knight, 2011). Growing a positive learning culture through alignment between individual teachers’ needs and the school improvement agenda is also recommended for school leaders by the Queensland DoE (EIRC, 2021b). The deputy principal role at Reservoir State High School affords this RC with an opportunity to embed a coaching approach for teacher PL. Strong leadership, openness, trust, and teacher voice is inherent in the RC’s coaching approach, and the recent DoE publications (e.g., DoE 2020, 2021b, 2022a) are encouraging for the future of coaching programs to support secondary teachers’ disciplinary literacy learning.

The notion of job-embedded PL, which occurs in authentic settings over a period of time, could allow teachers like Sally to push through their comfort zone and implement disciplinary literacy learning. With reference to this factor, Sally noted:

> I also agree with what George said about having the opportunity to think aloud your ideas and go through what you did better, or how you’re going to implement something for the first time. And kind of step it through, think it through with someone who knows about it and gives you that sounding board, and then helps you to grow your confidence a bit. (P1, Focus Group 2)

Sally’s reflection about coaching and her disciplinary literacy learning is similarly evident in the coaching literature. When a coach has a good understanding of how

much their coachee knows about a topic, collaborative conversations and appropriate resources will be more effective (Knight, 2009). Initial questions and conversations with the four participants included aspects of their prior coaching experience, along with some disciplinary literacy content questions. Once the individual interviews had occurred, the shared understanding between coach and teacher meant particular resources and strategies were suggested or provided by the RC to support each teacher. (Appendix E lists the range of shared resources provided by the RC.)

It is evident that despite the challenge of regular meetings, coaching observation cycles, and the impact of a global pandemic, the four participant teachers gained significant benefits from engaging in social learning through supportive, collegial interactions in a CoP.

7.1.1.3 *Teacher as Collaborator*: Advocates for Coaching

This sub-theme represents participants' experiences about coaching as a PL approach to developing disciplinary literacy learning. The previous two sub-themes of collegial engagement and supporting and validating colleagues built towards this third sub-theme: *advocates for coaching*.

During the final focus group, participants were asked about the ways coaching had influenced their disciplinary literacy learning. Sally was asked if she thought coaching had been helpful for learning about the disciplinary literacies of mathematics. Her reply was instructive:

> Yes, I wouldn't have had exposure to it [disciplinary literacy] otherwise. I think that the more we can talk about this as a maths faculty the better, and coaching can be a part of that kind of conversation, about how we talk about maths, how we get kids to talk about maths. (P1, Focus Group 2)

Sally's support of coaching for her own disciplinary literacy learning includes acknowledgement that coaching could support PL more widely. She refers to the idea that coaching could be implemented as a faculty-level approach. Campbell and van Nieuwerburgh (2018) explain the notion of a coaching culture and how positive learning environments share beliefs and practices that support such a culture in schools. While Campbell and van Nieuwerburgh focus on coaching in educational settings and school leadership, aspects of coaching which are beneficial to all include

increased self-awareness, self-confidence, and willingness to support the development of others.

Other participants responded to the question about ways coaching had influenced their disciplinary literacy learning. When asked whether coaching had given a boost to his knowledge and understanding of the disciplinary literacies of mathematics, Harry responded:

> Definitely. Before this process I had a very limited understanding of the disciplinary literacies of mathematics. And an almost inconsequential or sort of gloss-over approach to how they [disciplinary literacies] scaffolded in with, or sort of complemented, mathematical understanding. (P2, Ind. Int. 2)

Through participation in the coaching program, Harry's awareness of disciplinary literacies began to grow, and his revealing admissions confirmed the literature about the lack of secondary teachers' incorporating disciplinary literacies in their planned instruction (Di Domenico, 2014). George was also asked if he thought a coaching approach was a good way to support disciplinary literacy learning. He noted:

> It's good to have that one-to-one, that focus on specifically maths literacy and some learning about that, applying things, you know, little bits and then getting feedback on how they went, or at least talking them through with someone. Particularly as the literacy side of the equation for many of us maths teachers, we're very good at the subject, and we can autopilot and do many of these things very quickly. But it's that explicit knowledge of how to maybe do things more in that literacy sense of the learners that we aren't so automatic at this. (P4, Ind. Int. 2)

George's response aligned with T. Shanahan and Shanahan's (2008) concerns about more refined literacy practices needed in specific disciplines and the potential lack of explicit classroom literacy instruction for students in secondary school.

It can be argued that coaching has the potential to be used in a range of disciplines as an effective means to support disciplinary literacy learning. The literature notes concern for the level of secondary teacher preparation to deliver subject-specific literacy instruction (Brozo & Fisher, 2010; Fang, 2014). When participants were asked in the final focus group if they would access coaching for future PD, all four responded in the affirmative. Sally stated: "Yes, definitely, I'd do coaching again"; George said, "I think it was very worthwhile; I'd like to do it for a longer period of time and then see what benefits come from that"; and Harry said,

"Yes, definitely, you know my thoughts on people in classrooms, so yes." According to Pete, the value of coaching was evident in what happened in the classroom: "Think of the bump in student engagement; I would recommend it and I would do it again." Harry and George noted that more time would be preferable to build and reflect on changes in practice (P1, P2, P3, P4, Focus Group 2).

A variety of coaching types was outlined in Section 2.2.1. The two coaching types central to this study are the disciplinary literacy coach (Elish-Piper et al., 2016) and the instructional coach (Knight, 2009, 2010). When discussing how participants felt validated and supported by this coaching program, the key elements of Knight's partnership approach resonated: equality, choice, voice, dialogue, reflection, praxis, and reciprocity (Knight, 2009, 2010). Knight states:

> Instructional coaches can listen to teachers' concerns, see and reflect back the good they see in them, and work in partnership, often in highly enjoyable, exciting conversations, to identify, learn, and implement practices that enable that teacher to reach more students. (Knight, 2010, p. 92)

Knight's (2009) partnership principles underpinned the coaching approach in this study. George shared his feelings about the RC as a trusted colleague during his second interview, which resonated with elements such as equality, dialogue, reflection, and reciprocity (Knight, 2009). When asked his thoughts about being observed and receiving feedback, he noted: "I think it's good, I think the coach in your case, yes, it's a non-evaluative thing, which is the key" (P3, Ind. Int. 2). George's use of the term *non-evaluative* is crucial to a successful coaching agenda. B. Tschannen-Moran and Tschannen-Moran (2011) explain the difference between evaluation and development; the former is a process typically found in bureaucracies, and development is integral to professional organisations. If it is true that "schools have always combined both bureaucratic and professional elements" (B. Tschannen-Moran & Tschannen-Moran, 2011, p. 3), then coaching programs and the work of coaches must be clearly articulated to ensure teachers explicitly understand coaching as development and not as performance evaluation.

George further stated how trusting the RC allowed for more opportunities to learn: "Trust I suppose is the big thing. Because only then are you willing to try things that are new and that you don't know how it's going to go" (P3, Ind. Int. 2). George also commented on the significance of different types of coaching feedback, not just

feedback about a new strategy or unfamiliar process. Despite being quite experienced and often observed by a range of teachers invited to his "open lessons" related to the school's pedagogical framework, George valued the one-on-one coaching process and opportunities for reflection as per Knight's (2009) partnership principles of dialogue – "believing in the importance of conversations that enable people to think together" (p. 53) – and reflection:

> believing that learning can be enhanced when we have numerous opportunities to consider how what we're learning might impact what we have done in the past, what we are doing now, and what we will be doing in the future. (p. 54)

When reflecting on the advantages of a coaching approach at the faculty level within a school, George noted:

> If you've got a number of people in a faculty who are in a coaching cycle say, or [have] this common goal in mind or this common theme behind what they're doing, I think it can help the faculty in that those experiences and those new skills if you like … can be shared with colleagues. Colleagues themselves are the most powerful influencer of each other, and so I think anything we're going to do to empower mathematics teachers to be skilled in this area, and we can scaffold good experiences in the area, also has a multiplier effect. (P3, Ind. Int. 2)

The idea of implementing a coaching approach more broadly in the future at Reservoir State High School was discussed during the final data collection phase. Sally emphasised the benefits of collegial sharing, a way of working in a CoP to develop shared language and practices to support disciplinary literacy learning in mathematics, particularly in a large school with high expectations and an academic environment. She posited the idea that senior and advanced mathematics teachers could offer peer coaching to support teachers like herself, who were not mathematics trained. As Sally put it, "My maths is good, like really good, and I loved maths at school, and I love teaching maths. But I just model everything on my old maths teacher and what she did" (P1, Ind. Int. 2). As a starting point for her own mathematics instruction, Sally modelled practices from her own experience as a school student. In her final interview, she noted, "There's lots of things I would like to continue doing and learning about and there's lots of ways I think I could improve …" (P1, Ind. Int. 2). Sally's willingness to engage with coaching, to seek further learning opportunities to support her own learning, to benefit student learning in mathematics is significant when considering her own identity in the mathematics faculty. The current availability of teachers in

Queensland schools is directly impacted by workforce shortages across all subjects, but particularly for mathematics (ATWD, 2021). Further discussion in Section 7.2 addresses out-of-field teaching and workforce influences.

Sally's reflections indicated that she saw the potential for a collaborative model such as coaching to align teachers' knowledge and understanding of disciplinary literacies in mathematics. She noted:

> A lot of the teachers that have those skills and the knowledge and the practice would probably get a lot out of coaching out-of-field maths teachers, and it would just create a more common language. I think it would increase respect as well. (P1, Ind. Int. 2)

As previously stated in Chapter 2, Di Domenico's (2014) research found teachers had varying levels of understanding, particularly those teaching out-of-field. Sally's suggestion that peer coaching could provide targeted PD for teachers in the mathematics department at Reservoir State High School, and contribute to increasing the collective efficacy of the secondary mathematics teachers, was indicative of the need to raise awareness of disciplinary literacy. Fang (2014) states the need for literacy teacher educators in teacher preparation courses, particularly focused on increasing students' knowledge and understanding of disciplinary literacies, along with strengthening PCK (Shulman, 1986). While this may not directly support out-of-field teachers in secondary schools, thorough teacher preparation which included disciplinary literacy instruction could better prepare in-service teachers for seeking disciplinary literacy knowledge and processes of their expected role.

During the final focus group, the following question was asked: *Who has changed something in their teaching as a result of coaching in disciplinary literacy?* George provided an interesting response, which aligned with the *teacher as collaborator* theme because it demonstrated a positive perception of the coaching process and the importance of participation in a CoP and as a coachee:

> I think some of these things, I didn't have names for them, vocabulary labels for them before we did this, but I think some of the things we're talking about are the way that I always envisaged that I would instruct students in mathematics. (P3, Focus Group 2)

George further explained that the coaching program provided a sense of confidence in his capacity to reflect on students' needs, set aside the time to apply strategies, and learn different ways of working. He noted:

> I think any time we can look at the students and track back to what our actions should be, I think, and then have that self-awareness to say, "That's what my students need." Or, "I don't feel I have the confidence, or I might need to upskill"; that's probably where the most value, the most buy-in [for coaching] probably comes from. It's like a problems of practice kind of thing, and the agility of the coaching, because it might be, what you think they'll need might be different as the year goes on or a cycle goes on. (P3, Ind. Int. 2)

A response such as this demonstrates that the coaching program had potential to support teachers' needs, which vary from class to class and across different cohorts of students. The coaching program did not take a simplistic approach to PL; rather, it was a customised and meaningful collegial interaction with the overall desire to support and validate each teacher's disciplinary literacy learning. The coaching program was based on adult learning principles, with the teachers stating their goals based on the perceived needs of their students. This memo in the RC's reflective journal noted "a perception that a coach gives some stimulus to try a new way of working; more powerful if the teacher has expressed a desire or recognised a gap in students' ability" (RC, 2/5/21).

Further confirmation of participants making deliberate changes in practice as a result of their collaboration during the coaching program was evidenced by Harry in his final individual interview:

> Before this process I had a very limited understanding of the disciplinary literacies of mathematics. And an almost inconsequential, or sort of gloss-over approach, to how they scaffolded in with, or sort of complemented I suppose, mathematical understanding. Now, when I start to think about a problem, or start to think about some mathematical understanding that I want the students to get, it's almost like, well, that's the maths, but what's the understanding for the kids? How are they going to unpack it, how are they going to digest it, how are they going to understand what's going on in there? So, it's really framed for me the, I suppose, the duality of mathematics. Like, I think before, I was 90 per cent in the camp of, "This is the maths, the kids will get there because they know how to

> read." Whereas now I'm sort of like, the maths is important, but the access to the maths is just as important. (P2, Ind. Int. 2)

Changes in Harry's knowledge and understanding of disciplinary literacies, and potential changes to his teaching as a result of participation in this study, are affirming. His final statement, "the maths is important, but the access to the maths is just as important", reflects the underlying shift in Harry's approach to this pedagogical change. While all four teachers acknowledged that the coaching program contributed positively to their PL, due to some operational constraints, not all coachees (participating teachers) were observed the same number of times across the project. Despite this, ongoing collaboration both in person and via email with the RC as a positive contribution to PL was a constant thread throughout the data collection period. Working with mathematics teachers, who engaged with disciplinary literacy practices in a CoP to meet their students' learning needs, created greater awareness of how to provide better access to the mathematics.

The final section in this chapter reflects on the theoretical aspects of this study and how they related to the findings.

7.2 *Teacher as Collaborator*: Identity, Community, Practice, Meaning

A social theory of learning (Lave & Wenger, 1991; Wenger, 1998) was first introduced in Chapter 3. Key findings of this coaching project aligned with the theory's components of meaning, practice, community, and identity. This section reflects on the CoP approach embedded in the study and how it supported the participating teachers' experiences.

As coaching is inherently a social process, there was potential for all participants to professionally develop and create new knowledge in a trusted CoP. The four participants were not continually interacting with each other during the 10-week period; however, consistent interactions with the RC enabled elements such as mutual engagement, joint enterprise, and shared repertoire to shape their PL journey. The knowledge that other colleagues were actively engaged with the coaching project (joint enterprise), the focus of which was on developing mathematical literacies (shared repertoire) by forming a trusting coaching relationship (mutual engagement), indicated that a social theory of learning (Lave & Wenger, 1991; Wenger, 1998) was an appropriate theoretical framework for this project.

The opportunity to discuss and reflect on teaching and learning has been identified in the literature as a benefit for classroom teachers, given the tendency for social isolation in schools (Ciampa & Gallagher, 2016). It could be argued that despite the emphasis on collaborative learning for students, the nature of schools and staffing ratios make collegial engagement for teachers quite challenging. Section 3.2.5 outlined research into collaboration and the benefits of providing mathematics teachers with opportunities to engage with colleagues (T. Cox, 2011; Gellert, 2013; Mistretta, 2012; Rawding, 2013). By opening a professional dialogue about disciplinary literacies, the coaching program also opened classroom doors to encourage shared practices and feedback conversations. Wenger's (1998) work is based upon four premises about social learning, active engagement, and valued enterprises, however he states that "meaning is ultimately what learning produces" (Wenger, 1998, p. 4). The following discussion within the theme of *teacher as collaborator* reveals aspects of the participants' social learning opportunities, and the way the CoP has supported their growth.

Inviting the RC to observe a lesson or share social learning opportunities with a colleague encouraged less experienced teachers to gradually form the identity and practices of the group, known in the literature as LPP (Lave & Wenger, 1991). Sally acknowledged the nature of this form of participation in the second focus group:

> It's one thing to have a think about it [disciplinary literacy] and get some ideas, but if someone's coming to watch you do it, you really want to put it into practice to have the whole loop happen; so, then you can continue to grow. (P1 Ind. Int. 2)

Harry had previously introduced the notion of increased teacher accountability when another adult was present in his classroom during the first focus group. He reconfirmed this belief by adding: "I think what Sally said is really accurate, and I think she summed it up really well, actually; what I was thinking too" (P2, Focus Group 2). Pete reflected in his final interview about coaching as an approach to support teachers who have noted a gap in student learning and are looking to develop their own professional knowledge; he said, "The power of this one, though, was the fact that it [literacy focus] was teacher identified, even though you were sort of helping us with the resources and giving us some ideas about approaches." (P4, Ind. Int. 2). These extracts from Sally, Harry, and Pete are indicative of how the coaching program provided opportunities for building identity and meaning through LPP (Lave & Wenger, 1991).

Further to this point about identity, as previously mentioned, Sally did not complete pre-service teacher mathematics training, and noted the potential benefits of peer coaching from specialist mathematics teacher colleagues, which could support less experienced or out-of-field teachers. Within the social theory of learning (Lave & Wenger, 1991; Wenger, 1998), this is the way "learning as becoming" supports the participant's identity as a competent mathematics teacher. Sally expressed her ideas about disciplinary literacy coaching and the way it made her feel more accountable knowing that a coach was working with her to support her PL. Gellert's (2013) empirical study focused on early-career primary school teachers, a group who may not specifically be mathematics experts, and noted that the teachers developed stronger positive identity for mathematics through involvement in a CoP (Gellert, 2013). Gellert's study relates in part to this research project in that all four of this study's teachers were from predominantly science degree backgrounds. While this study focused on developing awareness of the disciplinary literacies of mathematics through a coaching program, the parallels between studies show benefits from teachers of all career stages working collaboratively in a CoP. Rawding (2013) conducted research which explored mathematics teachers' perceptions of collaborative learning teams. This nomenclature is similar in meaning to that of a CoP. Rawding's findings included benefits for novice and experienced teachers, as well as factors such as shared responsibility, a sense of belonging, and support with classroom-relevant content within a collaborative learning team.

It is interesting to note that several research projects in the body of literature relating to mathematics teachers and CoPs focused on elementary school settings (Gellert, 2013; Griffin et al., 2010; Mistretta, 2012). In Australia, elementary school equates to primary school, that is, students aged 6–11 years. This study was based in a secondary school context (students aged 12–18 years). However, while primary school teachers must generally work across a full range of subject disciplines and may not consider mathematics as their area of strength, it is becoming more apparent in secondary school settings that the subject of mathematics is being taught by out-of-field teachers. George's participation as a member of a disciplinary literacy CoP supported his ability to intentionally plan learning experiences directly related to disciplinary literacy for his students. He stated: "I think the power of this was to

become more aware of what I'm doing by naming it and labelling it. And then I could be much more intentional about it, if that makes sense?" (P3, Ind. Int. 2).

The *National Teacher Workforce Characteristics Report* (ATWD, 2021) data on out-of-field teaching is noted here. For example, it may be the case that a teacher has not received a graduate qualification in mathematics but has undertaken PL and in-service training to develop particular skills. Additionally, there may be a range of reasons why teachers are teaching out-of-field, and some of them are directly related to operational constraints such as staffing ratios at the school level. As previously noted in Chapter 2, given that the report cites the proportion of out-of-field teachers in mathematics at 24% (ATWD, 2021, p. 89), and if one quarter of secondary mathematics teachers have not received subject-specific tertiary study in content and pedagogy, there is a strong case for in-service PL opportunities such as coaching to support disciplinary literacy learning.

It must be noted that while they acknowledged the benefits of collegial engagement during the coaching program, two participants, Harry and Pete, had previously supported each other by spending time in each other's classrooms prior to their involvement in the study. Pete's openness to Harry's presence in his classroom refers to joint enterprise and mutual engagement; by accepting the presence of another teacher, processes, routines, and tacit knowledge are shared. Pete noted:

> Harry and I talk about it all the time, and we often just sort of wander into each other's classes, just because of the subject we're teaching. I think the power of this one, though, was the fact that it was teacher identified. I was on board from the start because there was already a conversation that I'd been having, sort of informally with Harry especially, and some other maths staff who teach the same subjects. I think it's definitely more powerful being teacher-led. So, if you were to go to some other teachers and say, you know, what do you think? What do you need? (P4, Ind. Int. 2)

Pete alluded to the idea of building a CoP through social learning opportunities in this quote. Lave (1991) refers to situated learning, which occurs socially and culturally when people are engaged in activity. Pete's willingness to walk into another colleague's room, or an early-career teacher's classroom, has parallels with what Lave (1991) refers to as old timers/newcomers; the way that newcomers gradually become old timers is a result of "legitimate access to ongoing community practice" (Lave,

1991, p. 68). With coaching and collegial engagement underpinning peer interactions, the identity and practices of the group should spread more readily.

7.3 Conclusion

In addressing the study's guiding research question – *How can an early-phase coaching program influence secondary mathematics teachers' disciplinary literacy learning?* – this chapter has presented the findings and discussion related to the third research sub-question, *How does an early-phase coaching program contribute to mathematics teachers' disciplinary literacy learning?* In doing so, it examined the third key theme, *teacher as collaborator*.

The analysis revealed that a significant element of a coaching program is the readiness of participants to collegially engage in a change process. The discussion of three sub-themes, *engages with colleagues*, *supportive of colleagues*, and *advocates for coaching*, illustrated different facets of this process. The discussion also revealed that the support and guidance provided throughout the coaching program at Reservoir State High School encouraged participants to engage with meaningful conversations about disciplinary literacies in mathematics and the subsequent application of this in their classroom practices. Furthermore, the emphasis on collaborative practice during the coaching program prompted meaningful professional reflection and learning among the four participating teachers.

In its discussion of findings, the chapter revealed how a CoP approach provided a lens through which four mathematics teachers' identity, community, practice, and meaning were foregrounded. The CoP approach supported a changing teacher identity while providing opportunities for pedagogical change. The presence of the RC supported out-of-field teachers to connect to mathematics through a disciplinary literacy lens, thus providing participants entry into the mathematics community.

The next chapter, Chapter 8, concludes this study. It comprises an overview of the research findings, the contributions of the research, limitations, and recommendations for policy, practice, and future research.

Chapter 8: Conclusion

This study examined how an early-phase, school-based coaching program influenced mathematics teachers' experiences of disciplinary literacy learning. It was guided by the following three research sub-questions:

1. *What disciplinary literacies do secondary mathematics teachers draw on when teaching mathematics?*
2. *How can an early-phase coaching program work to strengthen secondary mathematics teachers' disciplinary literacy learning?*
3. *How does an early-phase coaching program contribute to mathematics teachers' disciplinary literacy learning?*

The study's findings indicate that teaching mathematics through a disciplinary literacy lens involves deep understanding of disciplinary reading comprehension, vocabulary knowledge, writing, oral language, communication skills, and reasoning and investigating to operate mathematically. As little is known about the ways in which school-based collaborative forms of coaching impact on this form of PL, findings contribute new knowledge to research about the disciplinary literacy learning of secondary mathematics teachers. The following section briefly outlines how the study was structured prior to examining in more depth the significance of its findings.

Chapter 1 provided the background and context for the study, beginning with the focus on improving students' literacy and numeracy outcomes and the challenge of teaching the discipline of mathematics in a secondary school. The rise of coaching in educational settings to support collaborative PL was discussed, and key definitions of disciplinary literacy and coaching in education were provided. This chapter also detailed the study's theoretical framework, together with the qualitative case study research design and coaching program. Finally, Chapter 1 foregrounded the significance of this project's aim to investigate how a school-based coaching program could support mathematics teachers' disciplinary literacy learning. Chapter 2 reviewed the literature and research evidence related to the rise of coaching to effect change in schools. The nature and types of coaches, the notion of self-efficacy for teachers, the importance of collective efficacy in teacher communities, and the emergence of disciplinary literacy from content-area literacy were explicated This chapter also

focused on the significance of PCK (Schulman, 1986) and the ways in which it can be further refined to reflect the unique disciplinary literacy of mathematics, with discussion about disciplinary literacy coaching and collaboration to support teaching and learning in secondary schools.

Chapter 3 introduced the theoretical framework for the study, namely, a social theory of learning, and more specifically, the idea of teachers and a coach working together in a CoP (Lave & Wenger, 1991; Wenger, 1998). Four main components of a social theory of learning (Lave & Wenger, 1991; Wenger, 1998), namely, meaning, practice, community, and identity, were discussed with reference to how they aligned with the aim of the study and enhanced the experience of the coaching program for all participants. Chapter 4 explicated the qualitative research design and methodology for the case study, which commenced at the start of a school year, with data collection completed by the end of the first 10-week term. The premise of the study was realised through a qualitative, exploratory case study (Thomas, 2011; Yin, 2009) which explored the experience of four mathematics teachers and the RC in a coaching program introduced for PL in teaching disciplinary literacy in mathematics. Chapter 4 also detailed the data collection instruments. These included two semi-structured focus groups, two semi-structured individual interviews per participant, and the RC's reflective journal comprised of material collected via a cycle of RC observations in the classroom setting and collaborative conversations. From these data, and the insights, summary notes, and memos from the RC's reflective journal, an important finding was confirmed, that is, the participating secondary mathematic teachers considered that early-phase coaching *can* support their disciplinary literacy learning.

Chapters 5, 6, and 7 presented the findings and discussion in detail using the three sub-questions as the main organisational component. As this research was concerned with the early phase of collaborative PL in a coaching program and the participants had varying degrees of teaching experience and mathematical knowledge, the conversations about the disciplinary literacy of mathematics were at a formative stage. For example, prior to the first focus group, participants had not heard of, nor used the term, disciplinary literacy. Using thematic analysis (Braun & Clarke, 2006), three key themes were identified in the data and discussed in each chapter as follows: Chapter 5, first sub-question and first key theme, *teacher as learner*; Chapter 6, second sub-question and second key theme, *teacher as guide*; and Chapter 7, third sub-

question and third key theme, *teacher as collaborator*. Each theme is discussed in detail in Section 8.1.

As noted, Chapter 8 presents a summary of the major findings that explores how coaching can positively influence mathematics teachers' disciplinary literacy learning. The significance of the findings in the current education environment in relation to coaching and disciplinary literacy is also included. Suggestions for future research arising from this project are made, along with recommendations proposed for the teaching profession at large, including the staffing of schools to include site-specific coaches.

The impetus for this research project arose from the RC's practice-driven concern about the value of literacy coaching for mathematics teachers and desire to learn more about teachers' perspectives regarding the effectiveness, or otherwise, of disciplinary literacy coaching. This is significant because there has been a growing presence of coaches in schools and an awareness about coaching to support teachers' PL (Boyd, 2008; Dobbs et al., 2017; Elish-Piper et al., 2016; Fullan & Knight, 2011; Knight, 2009, 2010). The discipline of mathematics has unique literacy aspects which incorporate reading, writing, thinking, and processing (Lent, 2016; Moje, 2007, 2008). Students in secondary schools are faced with demands of an increasing specialisation of literacy across different subjects, which "means learning more sophisticated but less generalizable skills and routines" (T. Shanahan & Shanahan, 2008, p. 45). The issue is that students are less likely to receive this specialised instruction (Fang, 2014). Changes in the field of mathematics education and a greater focus on disciplinary literacy mean a shifting focus in professional needs of teachers, thus a change in skills required of coaches providing and/or leading the PL of teachers. Out-of-field teachers, those teachers working outside their formal training area, are particularly impacted by this shift and may need urgent and ongoing PL.

8.1 Major Findings

Three key themes were identified in the participants' and RC's accounts: (a) *teacher as learner*, (b) *teacher as guide*, and (c) *teacher as collaborator*.

The first theme, *teacher as learner*, was represented by sub-themes as follows: an increasing awareness of disciplinary literacy; working in different ways; being

coached for PL; recognising student needs; and experimenting. From the outset, the participants were engaged with the notion of disciplinary literacy learning in mathematics. Their awareness began to grow, as evidenced by their reflections on their own learning and the impact on student learning in coaching conversations. Once the teachers could see changes in their students' learning as a result of a disciplinary literacy strategy, they worked with the RC to learn more about topics such as close reading and mathematical discourse and to trial different approaches in the classroom. During the early learning about disciplinary literacy, participants began to note a tension between the top-down expectations of the Australian Curriculum, such as mandated content or the expectation that across the school mathematics teachers would implement a linear problem-solving model (QCAA, 2019), and the value of time to collaborate to further teachers' disciplinary literacy learning.

Teacher as guide was the second key theme in the study. Sub-themes included engaging, challenging, prompting, and cueing; giving options; providing student collaboration opportunities; and modelling. Pedagogical changes were noted by the RC as the project unfolded across the term. Shulman's PCK (1986) provided valuable insight into changing classroom pedagogies and the foundations of good practice for teaching mathematics. Newly acquired knowledge and understanding of disciplinary literacy helped participants to engage students and support their collaborative efforts in the classroom. Participants notably encapsulated the *teacher as guide* theme in their classrooms as planning and delivery began to incorporate each sub-theme, supporting students to understand the iterative nature of learning mathematics, literacy, and the different ways of working. A key aspect of the *teacher as guide* theme was the developing awareness for students of mathematical discourse and the importance of vocabulary and mathematics language.

The third theme, *teacher as collaborator*, encapsulated the collegial and social interactions between four teachers and a coach learning about the disciplinary literacy of mathematics. Sub-themes included engaging with colleagues, supporting colleagues, and advocating for coaching. Deep, instructional collaboration (Kise, 2009) occurred as a result of the coaching program. In coaching conversations, participants shared their experiences with the RC, which led to a willingness to try new pedagogies and disciplinary literacy practices in the classroom. The teachers

appreciated the focused time to collaborate and refine their disciplinary literacy learning and were supportive of an ongoing coaching approach for PL and sharing.

The findings and discussion provided a compelling argument for supporting mathematics teachers' disciplinary literacy learning through an early-phase coaching approach. The pedagogical and content knowledge of mathematics teachers is likely to change significantly over a teaching career; therefore, the relational and trusted presence of a coach and the cyclical nature of the coaching program to support teachers' disciplinary literacy learning was valued by the participants. Through the RC incorporating andragogy and focusing on adult learning principles, the teachers recognised immediate relevance to their work, noting that the disciplinary literacy lens and coaching approach addressed some problems in the mathematics classroom related to their students' ability to independently read, interpret, and communicate mathematically. A significant factor in the teachers' engagement with disciplinary literacy learning was the feeling of support from the RC and each other.

Disciplinary literacy (Dobbs et al., 2017; Elish-Piper, 2018; Moje, 2008; T. Shanahan & Shanahan, 2008) has evolved from a content literacy approach (Fisher et al., 2011; Lapp et al., 2004; Rapp Ruddell, 2008) and has the potential to support teachers in preparing secondary school students for competent understanding of the unique habits of working within the disciplines. This study has identified that coaching for disciplinary literacy learning is a powerful form of ongoing, supportive PL for in-service teachers and, at this research site, out-of-field teachers. It revealed that coaching did contribute positively to four participants' growing awareness of the disciplinary literacy in mathematics.

Since the beginning of the project, a key factor for the RC has been the potential for the further development of coaching skills and disciplinary literacy learning. Elish-Piper et al. (2016) state that "the coach is a collaborator, not an expert" (p. 17); therefore, the mathematics teachers were the content experts, and together with the RC, all participants developed knowledge about the disciplinary literacy of mathematics. Knight's (2009) partnership principle of reciprocity, "believing that every learning experience we create provides as much of a chance for us to learn as it does for our learning partners" (p. 54), guided the coaching practice of this study.

8.2 Answering the Research Questions

Drawing on the relevant findings of this study, as presented in Chapters 5, 6, and 7 and reviewed above, it is now possible to answer the research sub-questions.

In response to sub-question one – *What disciplinary literacies do secondary mathematics teachers draw on when teaching mathematics?* – the research found that the four participants used a range of strategies to support students' learning in mathematics. These strategies included:

- setting out and formatting written equations using consistent written communication;
- using a shared problem-solving framework from the QCAA (2019) – formulate, solve, evaluate and verify, communicate – to support problem-solving processes;
- foregrounding key vocabulary, including everyday words which have specialised mathematics meanings, specialist and technical language, and synonyms;
- using mnemonics and acronyms to represent multiple steps in a process; and
- providing students with context and relevance to provide authentic, engaging interactions for mathematics learning. This included the use of narrative or storytelling elements to represent abstract concepts and the use of contextual problems and relevance to support student engagement and learning.

The second sub-question – *How can an early-phase coaching program work to strengthen secondary mathematics teachers' disciplinary literacy learning?* – drew upon the participants' experiences and the RC's observations and discussion during the coaching program. The study found that the teachers noted a developing awareness of the disciplinary literacy of mathematics and began to intentionally plan and deliver their lessons to guide their students and introduce them to disciplinary literacy practices. By introducing the CUBES strategy (Twinkl, n.d.) or mathematical discourse practices to their students, the teachers were able to discuss and receive feedback from the RC to support new pedagogical practices. As adult learners, the teachers valued the time to discuss their work as it related to areas of student need.

Teachers noted they were more motivated to learn when they noticed students being more engaged in learning. By the RC offering support in learning about disciplinary literacy and observing their teaching practices to provide feedback during the coaching program, teacher self-efficacy began to develop. A growing awareness of PCK (Schulman, 1986) and discussions about the language of mathematics enabled the RC to identify relevant disciplinary literacy resources, thus enabling participants to learn more deeply and providing the element of choice to do further reading.

The third sub-question – *How does an early-phase coaching program contribute to mathematics teachers' disciplinary literacy learning?* – identified aspects of coaching which support teachers' self-efficacy and identity. These included the presence of a trusted, experienced coach to enable participants to navigate a change process, with the support of a coach to observe teaching practices and provide timely feedback about the disciplinary literacy aspects of the lesson. If teachers' efficacy beliefs have a direct influence on their levels of effort and resilience when facing new challenges (M. Tschannen-Moran & Hoy, 2001), then this coaching program effectively supported the participants to incorporate new pedagogies and practices into the mathematics classroom. As previously noted in Chapter 6, positive perceptions about coaching to support disciplinary literacy learning at the individual level could also boost the collective efficacy of a teaching team. When members of the community are individually more confident, then there is potential for collective efficacy to be higher (Bandura, 2001).

A coaching program is also more likely to support sustainable change in teaching practices due to the ongoing, cyclical nature of feedback via professional collaboration and the components of a CoP, such as shared language and meaningful experiences and strengthening of identity as a disciplinary literacy practitioner. Table 8.1, previously presented in Chapter 5 (Table 5.1), summarises the study's key themes and sub-themes.

Table 8.1

Themes and Sub-Themes in the Study

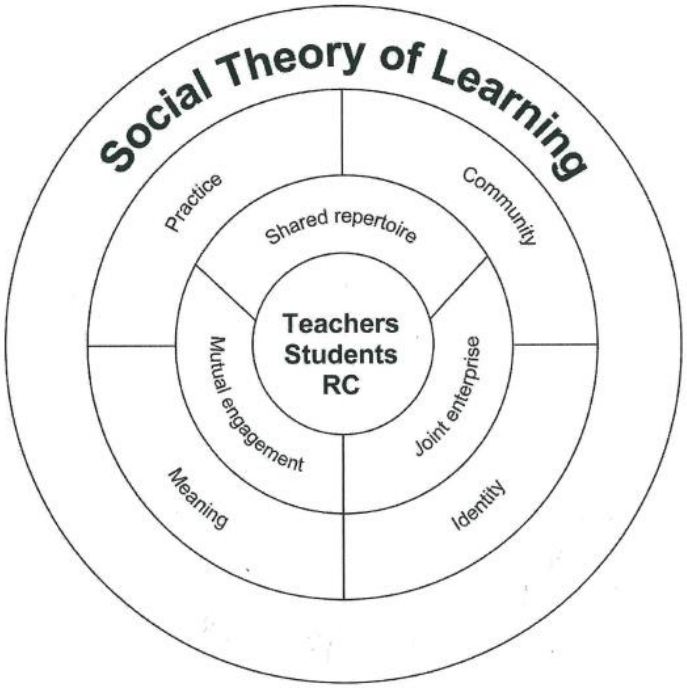
Theme	*Teacher as learner* Chapter 5	*Teacher as guide* Chapter 6	*Teacher as collaborator* Chapter 7
Sub-themes	Increasing awareness of disciplinary literacy	Engaging, challenging, prompting, and cueing	Engages with colleagues
	Working in different ways	Giving options	Supportive of colleagues
	Being coached for professional learning	Providing student collaboration opportunities	Advocates for coaching
	Recognising students' needs	Modelling	
	Experimenting		

8.3 The Contribution of the Theoretical Framework

A social theory of learning (Lave & Wenger, 1991; Wenger, 1998) provided the theoretical framework through a CoP lens. The components of a social theory of learning (Lave & Wenger, 1991; Wenger, 1998) include meaning (8.3.1), practice (8.3.2), community (8.3.3), and identity (8.3.4). Figure 8.1 illustrates the relationship between the components of the theoretical framework and the teachers, students, and RC.

Figure 8.1

Relationship Between Theoretical Framework Components and Teachers, Students, and RC



Note. RC = researcher coach. Based on *Situated Learning: Legitimate Peripheral Participation*, by J. Lave and E. Wenger, 1991, Cambridge University Press; and *Communities of Practice: Learning, Meaning, and Identity*, by E. Wenger, 1998, Cambridge University Press.

In schools there are many opportunities to engage in learning communities which provide purpose and meaning through social interaction and collaboration. Groups may overlap, for example, the case study group, the mathematics teachers in their faculty, and groups of students inside the classroom. Some opportunities include informal groups, such as a staffroom collective of faculty teachers, or formal communities, such as a year-level team. This study created a disciplinary literacy CoP for the mathematics teachers and RC to develop shared understanding, trial new practices, and create the identity of a disciplinary literacy mathematics teacher. Through their participation in this community, developing and sharing disciplinary literacy practices, the four teachers with the RC created their own ways of learning and knowing.

8.3.1 Meaning

The coaching program provided participants with a range of new learning experiences. In addition, within each mathematics classroom, a CoP comprised of students and their teacher engaged in social learning was also evident. Observations of

participants' mathematics classrooms showed students engaging meaningfully and developing disciplinary literacy awareness through joint enterprise and mutual engagement with each other and the teacher as a separate and unique CoP. Once Pete's Year 12 students started to show increased levels of engagement, he was reassured that a disciplinary literacy approach had meaning for them, which could support their independence with problem-solving questions.

8.3.2 Practice

Practice, in this example, the social learning related to mathematics concepts, consisted of routines and language patterns used by students to express their learning. Sally's Year 7 students began to incorporate early mathematics discourse (communication) practices in their small-group interactions – for example, using accountable talk prompts with a peer, or turn-taking to solve equations with a partner asking clarifying questions. The impetus for Sally to continue her own PL about her practices was expressed in the second focus group when she said, "Learning about mathematical discourse and how we can support our students to become more confident to talk about mathematics concepts and processes, and describe the skills that they've learnt, has kind of opened a bit of a window and I just want to see more …". Sally's notion of opening a window provided a metaphor to represent the start of a deeper learning process and better understanding of disciplinary literacy practices. Sharing her learning with her students and colleagues, and meaningfully engaging in the pursuit of knowledge, typified the shared resources and practices of CoPs.

8.3.3 Community

Belonging to a community of disciplinary literacy teachers provided a relational foundation for the mathematics teachers to explore new ways of working. The coaching program enabled teachers to collaborate, share, and discuss their experiences with each other and a trusted colleague, the RC. The community provided a set of supportive relationships which encouraged the four participants to take risks, challenge themselves, and be vulnerable. Participants reported that the presence of the RC, and the nature of the coaching program, enabled them to change or modify their practice. Post-observation discussions were timely and provided a social learning opportunity for teachers to reflect on their pedagogy.

8.3.4 Identity

The fourth component of a social theory of learning (Lave & Wenger, 1991; Wenger, 1998) is identity. George expressed the way his teaching had changed as a result of his membership in this community; he said it was the way he'd always envisaged that he would instruct students in mathematics. As a result of his participation in the study, and through engaging in the readings and coaching conversations, George reinforced his identity as a mathematics teacher. When considering social learning for mathematics teachers, coaching programs and a CoP approach in which collaboration and joint enterprise occur could encourage members to learn more deeply, thus supporting their identity as mathematics teachers.

8.3.5 Communities of Practice

The study also found that the three elements of a CoP were evident during the coaching program, namely, joint enterprise, mutual engagement, and shared repertoire (Wenger, 1998). At the heart of a CoP is social learning, and the four participants' experiences as active members of a community aligned with all three elements.

Fundamental to this joint enterprise was the trusted relationship between the teacher and coach, creating a sense of community as participants within the CoP. The coaching program followed a cyclical pattern which focused on disciplinary literacy practices as applied by each teacher in their mathematics classroom. Each coaching observation concluded with an inquiry process, framed as a coaching conversation, which focused explicitly on the disciplinary literacy aspects of the lesson. Another finding in this study relates to the notion of a CoP which developed in mathematics classrooms. For example, in Sally's Year 7 classroom, she noted that her students began to develop mathematical discourse practices and shared language, were more able to communicate about their learning, and co-regulated roles and relationships. George's Year 8 students collaborated in groups which had clearly defined roles, and he facilitated a shared understanding of the way mathematical language, norms, and practices create social learning opportunities. By modelling to his students, George was able to use prompts and cues to encourage mathematical communication.

Mutual engagement is about people doing things together, engaging and collaborating to form productive, professional relationships. This study's findings

about the benefits of social learning via a coaching program mean that other PL agendas may embrace this method. The final element of a CoP, shared repertoire, was focused on the routines, artefacts, and shared vocabulary which became part of the development of disciplinary literacy practices implemented by the teachers.

The RC in the CoP benefited from the PL opportunity through engagement with mathematics teachers, sharing their content knowledge, which combined with mutual discovery of disciplinary literacy practices. The RC also built capability about social learning, and the components of productive communities engaged with a shared interest. This included recognised practices and active participation which led to a stronger identity as a coach.

8.4 Self-efficacy and Collective Efficacy

Positive teacher self-efficacy and collective efficacy (Bandura 1977a, 1977b, 1982, 2000, 2001) were found to contribute to participant outcomes, as demonstrated in the findings and discussion of the second research sub-question (Chapter 6). In the literature, researchers noted the way teachers' perceptions of their efficacy was impacted by positive student outcomes. As an example of this, when Pete introduced a new disciplinary literacy strategy to his Year 12 students, it resulted in an improvement in their ability to independently read and interpret worded problems.

Whereas unsuccessful experiences can lead to poor self-efficacy, the fact that participants reported that the coaching program supported their disciplinary literacy learning reinforces the significance of collaborative PL such as coaching.

8.5 Limitations and Delimitations

It is widely acknowledged that qualitative research study design may be unique to a specific setting and results may therefore not be replicated in other settings. (Creswell, 2014; Denzin & Lincoln, 2000; Neuman, 2003). In this study there were two limitations and two delimitations. The limitations were the lack of time available due to full-time teaching commitments and the inability for the RC to meet with all study participants individually an equal number of times for the observation and feedback phase. The two delimitations, that is, RC-imposed choices, were study duration and participant sample size.

As previously discussed in Chapter 4, all participants worked full-time as either a teacher on a maximum load or, in the case of the RC, a deputy principal. The small number of study participants was intentional due to the constraints of the educational setting and the scope of this particular research study. Due to challenges beyond the control of the participants and the RC, some observations were not carried out as originally intended. Additionally, because the study was conducted over one 10-week school term, of necessity the RC focused on an introduction to, and building awareness of, the disciplinary literacy of mathematics.

The disciplinary literacy concepts that subsequently emerged as immediately relevant and of prime concern to the mathematics teachers were "mathematical discourse" and "reading and interpreting worded problems". The RC acknowledges there are many other aspects of mathematics disciplinary literacy that were not addressed in this study. Nevertheless, this critical introduction has the potential to be further developed, and it is hoped that this growing awareness translates into a genuine, ongoing, and sustainable learning process for all participants.

The impact of the COVID-19 pandemic on the timing of this study must be acknowledged. Specifically, the start of the data collection phase of the study was delayed by a full school year, and the final focus group and individual interviews became Zoom sessions instead of face-to-face interactions. This was not the preferred method due to the semi-structured nature of these sessions; however, valuable data were gathered.

8.6 Recommendations

A coaching program provided an opportunity for four mathematics teachers learning about the disciplinary literacy of mathematics at Reservoir State High School. The potential for site-specific coaching programs with a focus on disciplinary literacy in other schools is significant. This study served to create an awareness of disciplinary literacy in mathematics through the coaching program for four secondary mathematics teachers at the research site. Conversations between the RC and the teachers were valued, and additionally, participants shared their experiences and learning with each other in focus group discussion. Due to the positive outcomes of the coaching program, the benefits of a CoP, and the focus on disciplinary literacy, it could be argued that this

form of PL could be beneficial for other schools where there is a culture of trust and an appetite for collaboration and learning.

A key recommendation arising from this project is the endorsement of re-reading or close reading in mathematics (Snow & O'Connor, 2016). The teachers in this study highlighted the importance of learning how to teach students how to read closely in mathematics and explicitly modelling this. C. Shanahan et al. (2011) emphasised this reading strategy after researching ways expert mathematicians read. This strategy was first discussed in theme 1, *teacher as learner*, sub-theme, *working in different ways*, and is encompassed by theme 2, *teacher as guide*, sub-theme, *modelling*. Harry initially expressed his reservations in the first focus group about having to read three times (colloquially called the three-reads strategy). This was prior to the RC sharing disciplinary literacy resources and readings. During Harry's first interview, it emerged that his goal was improving his students' ability to read and interpret worded problems. After introducing and modelling the three-reads strategy in his Year 8 classroom, Harry noted in the final focus group that this strategy helped his students to independently read and interpret worded problems.

Another recommendation from this study is the presence of coaches to support a sustainable change agenda while building teacher capability; this recommendation is underpinned by Fullan and Knight's (2011) assertion that coaching works to embed educational change initiatives over time. It is notable that prior to the study, three of the four participants had not engaged with PL through a coaching approach. There may be a range of reasons why coaching as a means to support teacher PL has not yet become more accessible in schools. Mraz et al. (2008) conducted research focused on expectations and perceptions of literacy coaches and determined that the role of coach is open to interpretation by school leaders, coaches, teachers, and schools. "The jobs literacy coaches fill in schools are as varied as their titles" (Mraz et al., 2011, p. 142). Without clarity of the role, a clear position description, and ongoing communication across the school, the role of the coach may be unclear, and thus outcomes for PL for teachers will be varied also.

Establishing a relationship of trust between coachee and coach is a critical first step (Markovic et al., 2014) which may need time to develop. When implementing change agendas, the notion of implementation time may prevent schools with limited human and financial resources from considering coaching as a PL option. To reinforce

this point, Boyd (2011) states that "coaching is not for everyone, and it is expensive" (p. 36). Boyd's (2011) warning is reinforced by explaining the challenging nature of reflective practice inherent to good coaching and the importance of strong, enlightened, school leadership to drive improvement agendas. The coaching program in this study was supported by a trained literacy coach; if schools are unable to fund training and allot time within the staffing allowance for a full-time coach, perhaps peer coaching could be introduced as a starting point. Sally noted the potential within faculties for senior mathematics teachers to engage with peer coaching as a way of supporting teachers who do not have mathematics training. The participants felt that the coaching program provided the time to discuss pedagogy and share ideas to support students' gaps in knowledge. When learning new ways of working, a collegial approach is very supportive.

Other reasons that coaching may not be offered in some schools could be the misconception that coaching is a strategy to "fix" teacher performance or that it is linked to some form of teacher evaluation. B. Tschannen-Moran and Tschannen-Moran (2011) note the push for school leaders to adapt, collaborate, and drive improvement agendas; however, "a common mistake is to link evaluation and coaching as cause and effect" (B. Tschannen-Moran & Tschannen-Moran, 2011 p. 12). Blurred lines between strategies to support teacher improvement and conflate this with teacher evaluation can result in teachers being wary or uncertain of the potential of a coaching agenda. Elish-Piper et al. (2016) contend that disciplinary literacy coaching is most effective if a school already has an established, collaborative PL culture. Alignment between the school or district's explicit improvement agenda, the school's established learning culture, and a teacher's own PL goals also needs to be considered when introducing coaching (Fullan & Knight, 2011). Strategic planning and strong leadership will lay a foundation for teacher PL which embraces reflective practice and collegial engagement (Fullan & Knight, 2011; Goddard et al., 2015).

Resourcing schools to enable coaching programs to support teacher PL is recommended. Collaboration and ongoing, sustainable programs that are informed by teachers in relation to their PL needs are required. By consulting teachers about their PL needs, and supporting collaboration and sharing of years of experience, valuable insights from experienced teachers could be shared with those starting their careers. All four participants, who were at different career stages, reported growth in their

disciplinary literacy awareness and valued the time to discuss their teaching practice and reflect on disciplinary literacy feedback provided in the coaching program. By implementing a coaching approach and CoP framework, valuable insights from experienced teachers can be shared with early-career teachers.

8.7 Directions for Future Research

As a result of the RC's experiences and the outcomes evidenced through the analysis in this research study, additional areas for future research are considered. First, educational research for in-service PL for teachers could further explore the potential of coaching for disciplinary literacy. As the four mathematics teachers from this study benefited from disciplinary literacy coaching, then perhaps other subject-area teachers could benefit from a coaching approach to support disciplinary literacy learning. Projects may range from short-term coaching cycles through to longitudinal studies, where deeper disciplinary literacy learning has the potential to develop. It was noted by the four participants that as a result of their involvement in this study they started building disciplinary literacy awareness; however, due to the short-term nature of the project, the long-term implications could not be assessed.

Second, other research avenues could include coaching for embedded, ongoing PL both within and across school clusters. Strong, supportive leadership at the school and district level is crucial for developing a strategic and sustainable coaching approach to PL. Sharing coaching expertise and resources can build collective efficacy and support both large and small organisations to develop capability across districts (Ferguson, 2014). Victoria's Department of Education and Training began a state-wide coaching approach in 2008 to provide teachers with sustainable, collaborative ways to improve student outcomes (Boyd, 2008; DEECD, 2014). Building leadership capacity via a coaching approach is another way to expand a collaborative, sustainable change agenda. By offering coaching roles and responsibilities as a career development opportunity, essential elements in a coaching program like collegial engagement and trust may be boosted.

8.8 Final Thoughts

The influence of coaching on mathematics teachers' disciplinary literacy learning has been soundly answered in the affirmative. Moreover, as the RC in this study, I was surprised and invigorated by the degree of learning which occurs when individual teachers collaborate in a CoP within an early-phase coaching program. From this project's inception, when I was a classroom coach learning about disciplinary literacy instruction and wondering how this could work for mathematics teachers, the study has provided me with the opportunity to authentically collaborate with mathematics teachers and conduct research as an RC, and it has opened my eyes to productive and valuable ways of working. By conducting research into coaching and the disciplinary literacy of mathematics, and by collaborating with mathematics teachers in a CoP, the social learning opportunities have enriched my own knowledge. Each interaction with a colleague sparked an idea, a change in practice, or a shift in thinking. This has been immensely satisfying and worthwhile work, as the study's findings indicate not only that secondary mathematics teachers value the opportunity to work with a disciplinary literacy coach, but that this experience has contributed to everyone's disciplinary literacy learning. As the RC, the mutual engagement and shared practices have expanded my professional repertoire of coaching skills and understanding of disciplinary literacy.

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Appendices

Appendix A:
Guidelines for Effective Disciplinary Literacy Coaching

Adapted from *Collaborative Coaching for Disciplinary Literacy: Strategies to Support Teachers in Grades 6–12* (pp. 17–18), by L. Elish-Piper, S. K. L'Allier, M. Manderino, and P. Di Domenico, 2016, Guilford Publications.

1. Build capacity.
2. Consider teacher knowledge.
3. Create sustainability.
4. Spend as much time as possible working directly with teachers and teacher leaders.
5. Situate the coach as a collaborator, not an expert.
6. Let collaboration develop.
7. Leverage coaching strategies.
8. Focus on student learning.

Appendix B:

Participants' SMART Goals

Participant	SMART goals
Participant 1: Sally	SMART goals: • By the end of Term 1, Year 7 students will independently use the CUBES reading strategy to read and interpret worded mathematics problems. • By the end of Term 1, Year 7 students will independently use the CUBES reading strategy to read and interpret worded mathematics problems and use student-led mathematics discourse to explain their thinking.
Participant 2: Harry	SMART goal: By the end of Term 1, students will independently use reading strategies to interpret worded problems.
Participant 3: George	SMART goal: By the end of Term 1, Year 8 mathematics students have improved their ability to read and analyse word problems in order to create an equation.
Participant 4: Pete	SMART goal: By the end of term 1, Year 12 Essential Mathematics students will independently read and interpret a worded question and write it as an equation.

Appendix C:

Lesson Observation Template

Day/Date/ Event	Reflections	Thoughts and wonderings
Coach Q&A	*How did the disciplinary literacy component of the lesson go today?*	
	What worked well? What else?	
	What would you change? Why? What would that look like?	

Appendix D:

Participant Information and Consent Form

PARTICIPANT INFORMATION FOR QUT RESEARCH PROJECT
– Semi-structured focus group / Interview / Email Correspondence Follow-up –

School-based coaching:
Examining disciplinary literacy learning for secondary mathematics teachers.

QUT Ethics Approval Number 1900001151

Research team

Principal Researcher:	MRs Robyn Buchanan-Hodgson	Masters student (Research)
Associate Researchers:	A/Prof Deborah Henderson	Principal Supervisor
	Dr Lisa van Leent	Associate Supervisor
	A/Prof Bronwyn Ewing	Associate Supervisor

School of Teacher Education and Leadership (STEL)
Queensland University of Technology (QUT)

Why is the study being conducted?

The purpose of this project is to examine disciplinary literacy learning for secondary mathematics teachers using a coaching model based on a communities of practice (CoP) approach

Coaching has been introduced into some schools as a method of on-going, embedded professional learning for teachers. The focus on educational outcomes for students has created a range of coaching types, including literacy and numeracy coaches; instructional coaches; and disciplinary literacy coaches.

This research project is being undertaken as part of a Master of Research in Education study for Robyn Buchanan-Hodgson. Robyn has worked as a coach in secondary education for the past four years.

You are invited to participate in this research project because you currently teach secondary mathematics at a government school.

What does participation involve?

Participation involves collaboration with three other mathematics teachers and a literacy coach over the course of one school term (10 weeks).

Your participation will involve:

1. Focus groups: At the beginning and end of the 10-week cycle, you will engage in an audio-recorded semi-structured focus group with the other mathematics teachers and the researcher/coach. Focus groups will take approximately 1 hour, and be held at a central, agreed location on the research site.

2. (Semi-structured individual interview with the researcher/coach: The audio-recorded individual interview will enable you to create a disciplinary literacy S.M.A.R.T. goal for the coaching cycle. Interviews will take approximately 30 minutes, and be held at a central, agreed location on the research site. You will be able to review a transcript of your responses after the interview. Potential questions will include:
    - What do you know about coaching in schools? How does it work?
    - What type of literacy practices are needed in your mathematics classes? What can you students already do? What is next?
    - What disciplinary literacy strategy or approach are you most interested in developing?

3. Lesson observations and weekly conversations: you will be observed once per week by the coach in a designated lesson and coaching conversations will take approximately 10-15 minutes after each lesson observation. In these conversations you will be invited to share any relevant teaching resources or documents that you deem appropriate to matters discussed

Your participation in this research project is entirely voluntary. If you agree to participate you do not have to answer any focus group question(s) you are uncomfortable answering. If you agree to participate, you can withdraw from the research project at any time by contacting the researcher directly using the contact details provided here. If you withdraw any identifiable information already obtained from you will be destroyed. Your decision to participate or not participate will in no way impact upon your current or future relationship with QUT.

What are the possible benefits for me if I take part?

Your participation in this research project may not benefit you directly. However, as part of the coaching experience you may increase your professional learning about the disciplinary literacies in mathematics, which may improve your confidence to teach mathematics in the future. The outcomes of the research may also benefit other teachers and students, as the findings of the study may influence coaching programs in secondary education.

What are the possible risks for me if I take part?

There are minimal risks associated with your participation in this research project. These include time inconvenience, and perhaps some mild discomfort because participating in research and data collection activities can be a new and novel experience.

The researcher will consult with you and attempt to schedule all research activities at times and places that will best suit you. Your schedule will be prioritised, and the researcher will take all reasonable steps to ensure you are comfortable with the activities each time these occur. You will have an opportunity to ask any questions at any time during the sessions.

What about privacy and confidentiality?

Any personal information that could potentially identify you will be removed after transcribing or changed before information is shared with other researchers or results are made public. The information that will be removed includes things such as your name, school name, and location.

Any data collected as part of this research project will be stored securely as per QUT's

Management of research data policy. Data will be stored for a minimum of 5 years and can be disclosed if it is to protect you or others from harm, if specifically required by law, or if a regulatory or monitoring body such as the ethics committee requests it.

As the research project involves an audio recording:

- You will have the opportunity to verify your comments and responses prior to final inclusion.
- The recording will be retained for the minimum retention period of 5 years after the last research activity.
- The recording will not be used for any other purpose.
- Only the named researchers and a professional transcriber will have access to the recording.
- It is not possible to participate in the research project without being recorded.

Every effort will be made to ensure that the data you provide cannot be traced back to you in reports, publications and other forms of presentation. For example, we will only include the relevant part of a quote, we will not use any names, or names will be changed, and/or details such as dates and specific circumstances will be excluded. Nevertheless, while unlikely, it is possible that due to the small number of people associated with your school invited to take part in the research project, if you are quoted directly your identity may become known to others in the organisation as a participant in this research.

How do I give my consent to participate?

We would like to ask you to sign a written consent form (enclosed) to confirm your agreement to participate.

What if I have questions about the research project?

If you have any questions or require further information, please contact one of the listed researchers:

Robyn Buchanan-Hodgson	robynnoela.hodgson@hdr.qut.edu.au	04 2198 7333
Deborah Henderson	dj.henderson@qut.edu.au	07 3138 3048

What if I have a concern or complaint regarding the conduct of the research project?

QUT is committed to research integrity and the ethical conduct of research projects. If you wish to discuss the study with someone not directly involved, particularly in relation to matters concerning policies, information or complaints about the conduct of the study or your rights as a participant, you may contact the QUT Research Ethics Advisory Team on 07 3138 5123 or email humanethics@qut.edu.au.

Thank you for helping with this research project. Please keep this sheet for your information.

CONSENT FORM FOR QUT RESEARCH PROJECT
Individual, semi-structured interview / Semi-structured focus group / Email Correspondence and associated documents

School-based coaching:
Examining disciplinary literacy learning for secondary mathematics teachers.

QUT Ethics Approval Number 1900001151

Research team

Robyn Buchanan-Hodgson	robynnoela.hodgson@hdr.qut.edu.au	04 2198 7333
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School of Teacher Education and Leadership (STEL)
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Statement of consent

By signing below, you are indicating that you:

- Have read and understood the information documents regarding this research project.
- Have had any questions answered to your satisfaction.
- Understand that if you have any additional questions you can contact the research team.
- Understand that you are free to withdraw without comment or penalty.
- Understand that if you have concerns about the ethical conduct of the research project you can contact the Research Ethics Advisory Team on 07 3138 5123 or email humanethics@qut.edu.au.
- Understand that the research project will include audio recording
- Agree to participate in the research project.

Name _____

Signature _____

Date _____

Please return the signed consent form to the researcher.

Appendix E:

Disciplinary Literacy Readings: First Focus Group

1	Brozo, W. G., & Crain, S. (2017). Writing in math: a disciplinary literacy approach. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, 91(1), 7-13.DOI:10.1080/00098655.2017.1342435
2	Brozo, W.G., Moorman, G., Meyer, C. & Stewart, T. (2013). Content area reading and disciplinary literacy: a case for the radical center. *Journal of Adolescent & Adult Literacy 56*(5), 353-357.
3	del Prado Hill, P., Friedland, E. S., & McMillen, S. (2016). Mathematics-literacy checklists: a pedagogical innovation to support teachers as they implement the common core. *Journal of Inquiry & Action in Education, 8*(2).
4	Fang, Z., & Coatam, S. (2013). Disciplinary literacy: what you want to know about it. *Journal of Adolescent & Adult Literacy, 56*(8), 627-632. doi:10.1002/JAAL.190.
5	Fisher, D., & Ivey, G. (2005). Literacy and language as learning in content-area classes: A departure from "every teacher a teacher of reading." *Action in Teacher Education, 27(*2), 3-11. doi:10. 1080/01626620.2005.10463378
6	Hillman, A. M. (2014). How do secondary teachers apprentice students into mathematical lteracy? Feature article. *Journal of Adolescent & Adult Literacy, 57*(5). International Reading Association, 397-406.
7	Lee, C. D., & Spratley, A. (2010). Reading in the disciplines: the challenges of adolescent literacy. Final Report from Carnegie Corporation of New York's Council on Advancing Adolescent Literacy. *Carnegie Corporation of New York*.
8	Shanahan, T. & Shanahan, C. (2014). *Teaching disciplinary literacy*. Slideshow. University of Illinois at Chicago. www.shanahanonliteracy.com.
9	Summary of different ideas and strategies for Disciplinary Literacy learning in mathematics. Compiled by RC. Includes the following topics: reading, thinking, vocabulary/literacy, writing.
10	Walters, K. (2014, September). *Instructional coaching strategies to support student success in Algebra I.* (Research Brief.) American Institutes for Research. Retrieved from https://www2.ed.gov/programs/dropout/instructionalcoaching092414.pdf

Appendix F:

Disciplinary Literacy for Mathematics: Articles Provided to Participants – February 2021

1	Barton, M. L., Heidema, C., & Jordan, D. (2002). Teaching reading in mathematics and science. *Educational leadership*, *60*(3), 24-28.
2	Brozo, W. G., & Crain, S. (2017). Writing in math: a disciplinary literacyapproach. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas, 91(1), 7-13.* DOI:10.1080/00098655.2017.1342435
3	Brozo, W.G., Moorman, G., Meyer, C. & Stewart, T. (2013). Content area reading and disciplinary literacy: a case for the radical center. *Journal of Adolescent & Adult Literacy 56*(5), 353-357.
4	del Prado Hill, P., Friedland, E. S., & McMillen, S. (2016). Mathematics-literacy checklists: a pedagogical innovation to support teachers as they implement the common core. *Journal of Inquiry & Action in Education, 8(2).*
5	National Council of Teachers of Mathematics. (2010). *Discourse. Collection of manuscripts*. Mathematics teaching in the Middle School. Retrieved from https://www.nctm.org/uploadedFiles/publications/write_review_referee/journals/mtms-call-Discourse.pdf 1/8/21
6	Heidema, C. (2009). Reading and writing to learn in mathematics: strategies to improve problem solving. Adolescent Literacy in Perspective. www.ohiorc.org/adlit/
7	Hillman, A. M. (2014). How do secondary teachers apprentice students into mathematical literacy? *Journal of Adolescent & Adult Literacy, 57*(5). International Reading Association, 397-406.
8	Ippolito, J., Dobbs, C. L., & Charner-Laird, M. (2017). What literacy means in math class. *The Learning Professional, 38*(2), 66-70, 79.
9	Metsisto, D. (2005). Reading in the mathematics classroom. Chapter 2 in Kenney, L. M.., Hancewicz, E., Heuer, L., Metsisto, D., & Tuttle, C. L. (2005). *Literacy strategies for improving mathematics instruction.* ASCD: Alexandria, VA.
10	Paul, C.M. (2018). Building disciplinary literacy analysis of history, science and math teachers' close reading strategies. *Literacy 52*(3), pp 161-170.
11	**Annotated bibliography of the listed professional readings in this collection**. Collated and annotated by RC. **Includes the following topics: writing** (Brozo, W. F., & Crain, S., 2017); **content area reading and writing** (Heidema, C. 2009; Brozo, W.G., Moorman, G., Meyer, C., & Stewart., 2013); **reading** (Paul, C. M., 2018); **discourse theory** (Hillman, A., 2014; NCTM, 2010); **mathematics literacy checklists** (del Prado Hill et al., 2016)
12	Figure 1: The increasing specialization of literacy development (p. 44), excerpt from Shanahan, T., & Shanahan, C. (2008). Teaching disciplinary literacy to adolescents: rethinking content-area literacy. *Harvard Educational Review 78*(1). 40-59.

Note. Shading denotes articles not provided in full to participants; however, they were referenced in item 11, the annotated bibliography, collated by the RC.