Teacher Learning in the Context of Collaborative Online Workshops on Dialogic Pedagogy

Stephanie J. Beck

Ph.D. in Educational Psychology

Department of Educational and Counselling Psychology

McGill University

Montreal, Quebec, Canada

July 2022

A thesis submitted to McGill University in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Educational Psychology

Abstract

Dialogue-intensive pedagogies aim to promote high-quality educational dialogue critical for student learning. Unfortunately, professional development programs on dialogue-intensive pedagogies tend to be resource-intensive and uptake remains inconsistent. Inherent to this dilemma is the lack of research on the processes and mechanisms by which teachers learn dialogic principles and practices. Thus, this study investigates how teachers learn dialogic principles and practices while participating in a collaborative online research intervention on dialogic pedagogy. Twelve elementary and secondary mathematics teachers and two pedagogical consultants in Quebec, Canada participated in this study. Three cycles of collaborative online professional development, classroom experimentation, and follow-up reflection engaged teachers in joint explorations of discussion strategies and approaches for scaffolding students' metacognitive engagement with dialogue in the mathematics classroom. Workshops and individual pre-/postworkshop interviews were analyzed using a constructivist grounded theory approach and triangulated with teachers' classroom practices. Findings suggest that tacit factors, such as teachers' perception of students' special needs, played a decisive role in teachers' decision-making prior to workshop cycles. As teachers experimented with research-based practices, attention gradually shifted from struggling students to dialogically calibrated practice, provoked by teachers' critical self-reflection on their pedagogical assumptions. After the third and final workshop, teachers reported moderate changes to their teaching practice but significant effects on their pedagogical positioning. The majority of teachers associated these changes with the conceptual (dialogic-metacognitive) framework provided in the study, while others associated changes with self-motivating factors. This study reveals that collaborative programs

on dialogic pedagogy can have impact on teacher and student learning with relatively limited resources. Implications for teacher professional development and future research are discussed.

Résumé

Les pédagogies axées sur le dialogue visent à promouvoir un dialogue éducatif de qualité essentiel à l'apprentissage des élèves. Malheureusement, les programmes de développement professionnel sur les pédagogies axées sur le dialogue ont tendance à demander des ressources considérables et leur adoption reste irrégulière. Le manque de recherche sur les processus et mécanismes par lesquels les enseignants apprennent les principes et pratiques dialogiques est inhérent à ce dilemme. Ainsi, cette étude examine comment les enseignants apprennent les principes et les pratiques dialogiques tout en participant à une intervention de recherche collaborative en ligne sur la pédagogie dialogique. Douze enseignants de mathématiques du primaire et du secondaire et deux conseillers pédagogiques au Québec, Canada ont participé à cette étude. Trois cycles de développement professionnel collaboratif en ligne, d'expérimentation en classe et de réflexion de suivi ont amené les enseignants à des explorations conjointes de stratégies et d'approches de discussion pour aider les élèves à s'engager de façon métacognitive au sein du dialogue en cours de mathématiques. Les ateliers et les entretiens individuels avant et après les ateliers ont été analysés à l'aide d'une approche constructiviste fondée sur la théorie ancrée, et triangulés avec les pratiques en classe des enseignants. Les résultats suggèrent que des facteurs tacites, tels que la perception qu'ont les enseignants des besoins particuliers des élèves, ont joué un rôle déterminant dans la prise de décision des enseignants avant les premiers cycles d'atelier. Au fur et à mesure que les enseignants expérimentaient avec les pratiques basées sur la recherche, l'attention s'est progressivement déplacée des élèves en difficulté vers une pratique davantage calibrée sur le dialogue, provoquée par l'autoréflexion critique des enseignants sur leurs hypothèses pédagogiques. Après le troisième et dernier atelier, les enseignants ont identifié des changements modérés dans leur pratique pédagogique mais des effets significatifs sur leur

positionnement pédagogique. La majorité des enseignants ont associé ces changements au cadre conceptuel (dialogique-métacognitif) proposé dans l'étude, alors que d’autres les ont associés à des facteurs d'auto-motivation. Cette étude révèle que les programmes collaboratifs sur la pédagogie dialogique peuvent avoir un impact sur l'apprentissage des enseignants et des élèves avec des ressources relativement limitées. Les implications pour le développement professionnel des enseignants et la recherche future sont à l’étude.

Acknowledgments

I would like to take this opportunity to thank all the people without whose help and support this journey would not have been possible. Thank you to my supervisor, Dr. Alain Breuleux, and my thesis committee member, Dr. Susanne Lajoie, for their wealth of wisdom, for helping me to look past the branches and see the forest. Thank you to my research lab members, Nilou Baradaran, Chao Zhang, and Gyeong-Mi Heo, for all their stimulating intellectual conversations. I would like to send a tremendous thank you to the school boards, teachers, pedagogical consultants, students, and parents for seeing the potential in my research topic and for participating in this project. Without your help, this dissertation would simply not have been realized.

I would also like to acknowledge the financial support that I received during my doctoral studies from the Fonds de recherche du Québec - Société et culture (FRQSC).

Thank you to the teacher education and mathematics teams at McGill and Laval University, notably Dr. Claudia Corriveau, Dr. Marta Kobiela, Dr. Izabella Oliveira, Dr. Limin Jao, and many others, whose intellectual expertise has been the source of much inspiration throughout my dissertation.

Last but certainly not least, I would like to thank those dearest to me, those who were here to support me throughout this journey—to my parents, my brother and sister, to my partner and best friend. Thank you.

Table of Contents

List of Tables

List of Figures

List of Appendices

Chapter 1: Introduction

Statement of the Problem

Amidst today's diverse and interconnected global contexts, organizations around the world agree that education for the 21st century should help students develop the capacity to think critically, to communicate effectively, and to work collaboratively (Council of Ministers of Education, Canada, n.d.; Ministère de l'Éducation du Québec, 2017; National Research Council, 2013; OECD, 2017). This includes the ability to evaluate ideas critically and collaboratively through dialogue and to deepen collective understanding in a peaceful way.

Yet, research reveals the rarity of regular instances of dialogue in today's classrooms. Instead, many studies argue that the interactions found in classrooms are more often characterized as monologues (Galton & Hargreaves, 2009; Howe & Abedin, 2013; Smith et al., 2004). Unlike dialogue, a monologue is characterized by an over-abundance of simple "closed" questions, often characterized by IRFs (Initiation-Response-Feedback) (Sinclair & Coulthard, 1975) or IREs (Initiation-Response-Evaluation) (Mehan, 1979) that attempt to maintain tight control over the classroom or interactions by ensuring that teachers have the last word (Barnes, 1976). IRE/Fs entail teachers initiating a question (*Teacher: Who can tell me the answer to number five?*), to which students respond (*Student: One-third.*). The teacher evaluates the accuracy of the student's response (*Teacher: That's correct.*) and essentially closes the triadic sequence. Closed questions were highly criticized as they were assumed to restrict student thinking (Mercer & Dawes, 2014). In contrast, dialogue is characterized by a collective construction of meaning whereby members position themselves in relation to others and recognize diverse voices and perspectives (Bakhtin, 1981). In educational contexts, there is often an evaluative component associated with the notion of dialogue in the sense that teachers and

peers alike are expected to engage with others' views, justify their contributions, and essentially evaluate the relevance and validity of perspectives with respect to curricular goals (T-SEDA Collective, 2019; Mercer & Littleton, 2007; Vrikki et al., 2019).

Researchers agree that dialogue cannot emerge without a supportive environment, or a culture of dialogue (Alexander, 2008; Berkovich, 2016; van der Veen & van Oers, 2017). A dialogic classroom culture can be characterized by public access to collective knowledge and its criteria of evaluation (Michaels et al., 2008). Open-mindedness, mutual respect, freedom from censure, and reduced role division are also key criteria identified in the literature (see Robin Alexander's response, cited by Christine Howe in Asterhan et al., 2020). What's more, teachers' language also influences whether the classroom environment reflects a dialogic or monologic classroom culture. The coordination of learning activities, supported principally by the language that teachers use (Howe & Abedin, 2013; Leinhardt & Steele, 2005), signals to students the type of participation that is valued and how they are to develop such behaviors and mindsets (Mercer & Dawes, 2014; Wegerif, 2013).

Teachers' pedagogical practices are tantamount to the emergence of a culture of dialogue. For example, classroom interactions in the form of peer-led small-group tasks have been recognized as a major source of dialogic culture building activity (Alexander, 2008; Engle & Conant, 2002; Mercer & Littleton, 2007; Scott et al., 2006; Wegerif & Dawes, 2004; Wells, 1999). Research has shown that when the classroom learning environment is designed to help students develop peer-to-peer learning, small-group tasks contribute to students' educational success in science (Barth-Cohen et al., 2016), mathematics (Yackel et al., 1991, Hufferd-Ackles et al., 2004) and literacy (Newman, 2017). In line with a culture of dialogue, small group activities offer students the opportunity to practice articulating their thinking and to actively

listen and respond to others. By learning how to critically engage with their own and others' thinking, students develop communication skills and domain-specific knowledge, and become more self-regulated (Whitebread et al., 2013). These characteristics are undeniably necessary for quality dialogue in the classroom.

Indeed, teachers play an essential role in ensuring that dialogue and learning go hand in hand. Arguably, this involves complex processes of developing and maintaining a culture of dialogue. Often associated with dialogic pedagogy (Matusov, 2009; Wegerif, 2013), dialogic teaching (Alexander, 2004; Asterhan et al., 2020; Boyd & Markarian, 2011), or dialogue-intensive pedagogies (Wilkinson et al., 2015), a culture of dialogue ensures that students are not just using dialogue as a tool for individual performance, but that they are also understanding its value for the sociocognitive health of the classroom and its individual members.

Research shows that developing a culture of dialogue is far from being a straight-forward process. Certainly, teachers need to learn knowledge and practices related to dialogue and dialogue-intensive pedagogies. But how do teachers go beyond learning practices toward adopting a dialogic pedagogy?

In response to this dilemma, research has explored multiple avenues for helping teachers to build dialogue in their classrooms, notably through research-based collaborative workshops that encourage reflective professional conversations around the principles and practices of dialogic teaching approaches (Hennessy et al., 2018; Hofmann, 2020; Pehmer et al., 2015; Perry et al., 2020; Wilkinson et al., 2017). Dialogic teaching, or dialogue-intensive pedagogies more broadly (Wilkinson et al., 2015), explore pedagogical stances and practical approaches that help teachers and students become adept at participating in productive educational dialogue (Kim & Wilkinson, 2019). While progress has been made in supporting teachers' capacity to facilitate

productive dialogue in their classroom (Hennessy et al. 2021; Wilkinson et al., 2017), still little is known about the processes and mechanisms by which teachers adopt dialogue-intensive pedagogies (Hofmann, 2020; Lee & Tan, 2020).

Research Context

These questions are particularly relevant in Quebec, Canada as the Ministry of Education explores ways to support teachers' development of professional practices that encourage dialogue in the classroom. The concept of dialogue has a particular place in Quebec society and history. Situated within the Quebec Education Program (QEP) as one of the competencies of Ethics and Religious Culture (Ministère de l'Éducation, 2008a, 2008b), the subject of dialogue emerges as an important element in response to the history of religious tensions within Quebec up until the turn of the 21st century. In Quebec, schools were organized around the historically Catholic and Protestant religious leanings. When the Quebec school system shifted to a nonreligious system, school boards were restructured based on linguistic considerations rather than religious (denominational) considerations. In this conceptualization of education, dialogue is associated with personal reflection and exchanging with others and is envisioned as an essential component of a pluralist society that is open and tolerant of different points of view. Dialogue is described in the Program as a competency that is developed throughout the trajectory of students' education and as having connections with other QEP subject areas such as language arts and mathematics, amongst others.

While the QEP provides a general reference to the promotion of dialogue in different subject areas, a mathematics pedagogical consultant participating in this study shared how it is only recently that a math referential has been released (in French only), detailing more specifically what discussion-based activities might look like in the math classroom (Ministère de

l'Éducation, 2019). Even more recently, a newly updated reference for teachers' professional competencies was released, highlighting the role of education, and thus teachers, to promote the symbolic languages underpinning each of the disciplines in their singularity, to act as a "mediator of cultural objects" (Ministère de l'Éducation, 2020, pp. 20-21). The question then remains as to how teachers make sense of the culture underlying these symbolic languages and the underlying concepts of dialogue for learning in the mathematics classroom. If teachers and students are to know how to critically participate in dialogic learning environments, it is critical that research shine a light on teachers' perspectives and practices toward this end.

This study draws on a research program that was designed with these global and provincial goals in mind. Entitled *Scaffolding Students' Metacognitive Engagement with Dialogue*, the research-based professional development initiative included iterative cycles of collaborative workshops and follow-up classroom reflection and experimentation. Workshops were organized for elementary teachers, secondary mathematics teachers and mathematics pedagogical consultants to collectively explore the role of dialogue in mathematics education. Following each workshop, teachers were given the opportunity to reflect on and, in some cases, experiment with the research-based materials presented and to come back to their professional small groups—divided into either elementary or secondary level teachers—to discuss with fellow teachers any thoughts, perspectives, or challenges implementing or conceptualizing the material.

Purpose Statement and Research Questions

If classrooms are to become sites of dialogue for learning, it is crucial to understand the factors that help and hinder its emergence in the classroom. This includes developing a better

understanding of the processes and mechanisms through which teachers develop dialogue-intensive practices and pedagogies, specifically in the mathematics classroom.

This study thus explores whether and how participating elementary and secondary mathematics teachers adopt dialogic approaches to teaching and learning while participating in professional development on dialogic pedagogy involving collaborative online workshops and iterative classroom experimentation by asking the following three research questions:

1. How do participating teachers experience and conceptualize dialogue for learning in the mathematics classroom before participating in professional development on dialogic pedagogy?
2. What do teachers' workshop discourse reveal about the tacit knowledge and beliefs that influence math teachers' decision-making when planning for, implementing, and assessing dialogue for learning in their classroom?
3. What evidence is there that teachers changed their practices, perspectives, knowledge, or beliefs on dialogue for learning after participating in workshops and classroom experimentation on dialogic pedagogy?

Significance

This study responds to the dearth of in-depth qualitative research on teachers' perspectives and experiences adopting discussion-rich learning tasks in the mathematics classroom. While research has come a long way in revealing the importance of a classroom climate that encourages productive dialogue in the classroom, this study unveils the complexity of the psychological processes that teachers go through when adopting dialogue-intensive pedagogies.

This study is also significant in that it responds to the lack of substantive research investigating teachers' learning processes, and particularly the tacit knowledge that teachers use to decide whether and how to adopt dialogue-intensive pedagogies in the mathematics classroom. The collaborative, design-based inspired methodology sheds light on the complex processes of learning through teachers' authentic practice, which is essential to building stronger learning theory.

This study will also contribute to the much-needed research on ways to support communities, schools, and teachers who wish to improve or adopt dialogic teaching practices, specifically in mathematics classrooms but also in subject areas across the curriculum.

Furthermore, by developing an empirically based model of tacit factors and intervening conditions contributing to teachers' learning processes, future research can further test and build on our understanding of teachers' learning.

Philosophical Assumptions for Investigating Teacher Learning

A social constructivist interpretive framework (Denzin & Lincoln, 2000, 2008; Lincoln & Lynham, 2011) guided the design of this study. Constructivism assumes that psychological phenomena (e.g., knowledge, learning processes) are largely intangible, apprehensible as mental constructions—socially and experientially constructed and co-constructed (Guba & Lincoln, 1994). At the heart of these social experiences are the meanings and identities (e.g., pedagogical positioning, beliefs about learning) that individuals jointly negotiate as they interact with one another (Gee & Green, 1998). Identities and meanings grow and evolve as teachers develop competence within communities of practice (Wenger, 1998). Not only do teachers adopt the community's cultural signs and tools, but they also contribute back to it with their own personalized experience (Wenger, 1998). A dialogical ontology further expands these

perspectives by drawing attention to the inter-subjective dimension of meaning (Bakhtin, 1981; Voloshinov, 1929/1973) and thus learning (Nystrand et al., 1997; Wells, 2007), highlighting the importance of dialogue in the construction of knowledge and the mind.

Epistemologically, the dialogical aspects of learning highlight the fundamental role that semiotic, and thus discursive, processes play in individuals' ability to reflect on and subsequently influence the processes of meaning making and consequently learning (Bakhtin, 1981; Vygotsky, 1962; Wells, 2007). Through discourse, individuals' knowledge, understanding, beliefs, and motivations for participating in activity are brought to the fore (Engeström, 1999) and put in productive tension as the contradictions (e.g., epistemic distance between the abstract and the concrete) are dialectically addressed and, ideally, transcended through critical thought and collective re-imagining (Engeström & Sannino, 2010). Said in another way, this purpose can be collectively shared and expanded when purpose-driven activity intentionally integrates elements of reflection and perspective-taking (see Boland & Tenkasi, 1995). Thus, sociocultural perspectives (Davydov, 1990; Leont'ev, 1981; Vygotsky, 1934/1987) complement these dialogical perspectives, although not without paradigmatic tension (Packer & Goicoechea, 2000; Sfard, 1998; Wegerif, 2008, 2011).

By exploring teachers' professional discourse in a number of contexts, we might thus better understand what types of knowledge and beliefs that teachers bring to professional conversations on dialogue and learning and, subsequently, how reflective professional conversations about dialogic pedagogy and practices impact on teacher learning as well as student learning in the classroom. For researchers to be able to understand teachers' learning processes, not only must teachers' discourse play a central role in research, but teachers' purpose-driven discourse must also be considered and analyzed along its trajectory of change.

Axiologically, these processes allow individuals to develop psychological (semiotic) tools for understanding their own and others' activity, with the goal of assisting teachers develop agentic positions to take action in the world (Wells, 2007). Methodologically, this is accomplished through collaborative (Desgagné, 1997; Morrissette, 2013), design-based inspired research processes. These processes engage educators and researchers alike in critical and reflective professional conversations about teaching and learning (Bakker, 2018; Boschman et al., 2016) in order to improve teachers' understanding and uptake of dialogic pedagogy and related tools. In so doing, researchers and teachers co-construct a deeper understanding of the underlying factors that help or hinder teachers from engaging with dialogic theories and practices (Hennessy et al., 2021).

Summary of Methodology

The study is situated within a larger project entitled *Scaffolding Students' Metacognitive Engagement with Dialogue* using a multimethod qualitative research approach (Mik-Meyer, 2020). The project incorporates cycles of collaborative professional development, follow-up reflection and classroom experimentation. Participants were recruited from two school boards in Quebec, Canada. A total of 12 teachers—seven elementary teachers and five secondary mathematics teachers—from 11 different schools agreed to participate. Two pedagogical consultants specializing in mathematics education from one of the school boards also agreed to participate and to contribute their expertise during workshop discussions.

Data collected for this study include audio-/video-recordings and transcripts of three pedagogical workshops, organized online in response to the COVID-19 pandemic; teachers' pre-/post-workshop interview discourse (recorded and transcribed); classroom recordings; and observational notes and reflexive memos. A constructivist grounded theory approach (Charmaz,

2006; Strauss & Corbin, 1990) was utilized to analyze the data. Analyses centred on meaningful units (Linell, 1998) and teacher turns, analyzed iteratively through the constant comparative method (Glaser & Strauss, 1967; Hallberg, 2006). Presentation of findings follows a multimethod structure. In other words, the presentation of findings chronologically follows the nature of the discourse analyzed (e.g., Interview 1, Workshop Discourse, Interview 2). Additionally, multiple representations of discourse, analyzed with a grounded theory approach, are triangulated to ultimately strengthen the dependability of the theory-building processes employed and the emerging findings. In parallel to the figures and tables created to this effect, a strong narrative genre also underpins the presentation of findings. This format is privileged for its ability to help readers better understand how teachers' psychological processes are woven within diverse social contexts and experiences (Charmaz, 2006).

Definition of Terms

Dialogue

Dialogue is often associated with exchanges, usually spoken, between two or more people. Today, the notion of dialogue takes on a much broader definition, associated with the following ideas: (a) mutual respect; (b) empowering voices; (c) caring; (d) thinking, reflecting, and responding; (e) willingness to change or to change one's mind; (f) dialogue with oneself to influence or change one's behavior or thought; (g) different perspectives are shared; and (h) exchanges giving rise to new questions. Furthermore, actively listening and interacting respectfully with one another; explaining one's reasoning and justifying one's arguments on relevant and publicly available knowledge (Scott et al., 2006); active construction of meaning—all of these ideas draw our attention to important aspects of creating and maintaining dialogue.

The concept of dialogue, as it is used in this dissertation, also takes on a philosophical stance as it relates to the social, interpretive environment in which linguistic signs are situated (Voloshinov, 1929/1973; Wertsch, 1980, 1985) and which have the potential to influence the development of consciousness or thought (Vygotsky, 1934/1987; Zinchenko & Davydov, 1985). The notion of dialogue also takes on the notion of the quality of students' language (Mercer & Littleton, 2007). Vygotsky (1931/1981) theorized that the development of more advanced forms of mental development were intimately connected to individuals' ability to make use of tools and signs, particularly language. Conceptualizing tools and signs as intrinsically rooted in history and culture, investigating language and its development was thus as much an investigation of the trajectory of appropriation (i.e., enculturation) as it was of cognitive development (Leont'ev, 1981).

Two distinct forms of dialogue—scaffolded (teacher- or adult-led dialogue) (Vygotsky, 1934/1987) or student-led (i.e., symmetrical, peer-led, or collaborative dialogue) (Brown & Campione, 1996; Dillenbourg, 1999; Fernández et al., 2001)—are understood here as offering different but complementary goals toward student learning.

Dialogic Pedagogy, Dialogue-Intensive Pedagogies

In general terms, dialogic pedagogy includes the pedagogical perspectives and practices of engaging students in purposeful socialization for specific learning goals.

In this study, I use interchangeably the terms *dialogue-intensive pedagogies*, *dialogic teaching*, *discussion-rich practices*, to the extent that these terms mutually reflect a dialogic philosophy embedded in the goal of helping students develop the capacity to engage in critical educational dialogues.

It could be said that pedagogy, teaching, or teaching-and-learning practices become *dialogic* when teachers overtly communicate to students the important place that educational dialogue, or talking together in the pursuit of educational goals, holds in their learning and intellectual growth. A number of teaching approaches have been developed in this vein, to which researchers increasingly attribute the name dialogic teaching (Alexander, 2004; Burbules, 1993). Subsequently, dialogic teaching has come to include teaching approaches and pedagogies (Alexander, 2008; Fisher, 2007; Mercer & Littleton, 2007; Michaels et al., 2008; Nystrand et al., 1997; Resnick et al., 2015; Reznitskaya & Gregory, 2013; Trickey & Topping, 2007), ontologies (Burbules, 1993; Matusov, 2009; Wegerif, 2020), and critical conceptual orientations (Boyd & Markarian, 2011; Lefstein & Snell, 2014; Shor & Freire, 1987) that seek to create collaborative, supportive and critical classroom cultures. The notion of "dialogic stance" is also mentioned (Kim & Wilkinson, 2019) and can be likened to an attitude or disposition necessary to implement dialogic teaching (see Boyd & Markarian, 2011; Juzwik et al., 2013; Wells, 1999), although admittedly one that might take time to develop (Howe & Mercer; 2017; Sedova, 2017; Wilkinson et al., 2017).

The literature often highlights how much of the research on dialogic teaching has common roots in Robin J. Alexander's extensive work. However, dialogic teaching does not hold a unified definition, nor does it represent a unified conceptual stance (see Jolicoeur, 2020; Kim & Wilkinson, 2019). Such differences include, most notably, whether discursive practices in the classroom (e.g., the ways teachers plan for and facilitate discussion-/dialogue-based teaching approaches) are simply one of many strategies to be found in teachers' pedagogical "toolkits", in the sense of Alexander's (2008) *repertoires*, or whether they are expressions of teachers' epistemology (Wilkinson et al., 2017). In this study, we acknowledge the importance that

pedagogy plays in directing teachers' practices (Durkheim, 1922/2006). We pay special attention to these questions and, additionally, interrogate the way a dialogic pedagogical stance also directs the way researchers pursue a critical analysis of them (Asterhan et al., 2020; Mercer et al., 2020).

These ideas draw our attention to the ways that teachers ensure that students are building the capacity to participate in different types of educational dialogues (*plural*) (Baker, 2020). The literature suggests that helping students develop the capacity to participate in educational dialogues may help students develop metacognition and self-regulation (Whitebread et al., 2013). Research has suggested that promoting a specific type of communication that encourages self-reflection, such as those promoted through dialogic teaching approaches and pedagogies, hold promise (Fisher, 2007). Some have even suggested that developing students' metacognitive reflection through discussion-based practices may concomitantly build other cognitive capacities needed for related activities, such as self-directed problem-solving (see Mercer, 2013).

Research suggests that many teachers already adhere to pedagogical stances akin to dialogic pedagogy. Such practices are considered to be observable within classroom interactions, focusing primarily on the functional dimensions of classroom talk (dialogic moves) (Hennessy et al., 2016), but also the holistic dimensions, such as the emotional support, classroom organization, and instructional support provided (Muhonen et al., 2016), which are equally essential to dialogic pedagogy. For example, Muhonen et al. (2016) focused on the way that teachers scaffolded participation and shared understanding through dialogue. While they too emphasized the importance for students to articulate and explain their understanding, they highlight two important considerations that allowed students to take more responsibility: teachers

made connections to larger societal knowledge or moral rules when discussing subject concepts and teachers typically accepted the children's answers without judgment.

Scaffolding

The reasoning processes made known to children through speech and other signs cannot be taken for granted. Vygotsky emphasized the role of "adult guidance" or collaboration with the "more capable peer" interacting with a child in their unique *zone of proximal development* (Vygotsky, 1978, p. 86). Neo-Vygotskian directions (Mercer, 1994) would subsequently emphasize ways that more capable others, such as teachers, parents, or peer tutors, could help children focus on the heart of essential learning goals by temporizing secondary components that characterize a learning task but whose content could be temporarily waived until conceptual features are mastered.

Wood, Bruner, and Ross (1976) used the metaphor of *scaffolding* to illustrate this idea. However, Mercer (1994) cautions that the term has been loosely defined and, in some cases, inattentively employed to denote any kind of help given to students:

> 'Scaffolding' is clearly a form of help; but what kind of help is it? What are the specific features which help distinguish scaffolding from other forms of assistance? […] it is not just any assistance which might help a learner accomplish a task. It is help which will enable learners to accomplish a task which they would not have been quite able to manage on their own, and it is help which is intended to bring learners closer to a state of competence which will enable them eventually to complete such a task on their own. (Maybin et al., 1992, p. 188)

Maybin et al. clarify their use of 'task', arguing against a reductionist notion where task would be understood as one specific type of problem-solving task. Yet, they do not argue for an

abstract notion of 'task' either. As interpreted by Tabak and Kyza (2018), scaffolding implies that the teacher, or whomever is doing the scaffolding, "enables learners to experience a complete task rather than isolated components of a task. It, thus, avoids problems encountered by learners who master isolated task components but then, often with little guidance, have to figure out how to integrate all of the sub-skills into a full performance" (p. 192).

In the scaffolding metaphor, special attention is also given to the quality of the more capable other's ability to not only be consciously aware of the child's actual developmental level but, as emphasized in Vygotsky's notion of the zone of proximal development, to also know where a child's psychological threshold lies before they are no longer able to perform a task, in its entirety, on their own. With this knowledge, scaffolding takes place as the more capable other provides a child with a "vicarious form of consciousness" (Bruner, 1985, pp. 24-25) that is embodied in their supportive, intellectual, conversation-based assistance and that allows the learner to gradually internalize concepts. Here, the notion of "fading" (Collins et al., 1989) is essential, highlighting the way teachers gradually withdraw help so that students can gradually gain autonomy.

Small Group Tasks and Unpacking the Cooperation–Collaboration Debate

One specific task that has been increasingly incorporated in the classroom practices aimed at dialogic pedagogy has been the peer-led, small-group task, otherwise known as the cooperative task (Johnson & Johnson, 2002; Johnson et al., 1981; Slavin, 1980, 1996), the collaborative tasks, or simply group work. This trend has grown from theoretical perspectives that situate educational experiences in relation to the social nature of classroom activity. Indeed, researchers acknowledge that cognitive engagement and learning is a social, mutually constructed phenomenon (Säljö, 2009; Stahl, 2006). By constructing a conceptually-rich, shared

understanding of the problem and strategies to resolve it, critically engaging with multiple perspectives, and valuing the collective, mutual effort needed to build knowledge—students develop the social and communicative capacity to productively participate in collaborative curricular activities. The literature maintains that the social and communicative environment is an integral part of cognitive development and not a mere backdrop for individual cognition (Alexander, 2001). More generally, the literature shows that students in classrooms where teachers explicitly encourage students to use specific sharing, explaining, and questioning behaviors—and teachers model those behaviors for them—students remain on-task, give detailed help to their peers, and give more reasons and justifications for their responses during small group activities (Baines et al., 2009; Gillies & Khan, 2009; King & Rosenshine, 1993; Wegerif et al., 1999). Baines and colleagues (2009) found that, by simply promoting group work skills, students demonstrated high-level inferential talk as evidenced in instances when students think beyond the context of the problem.

Over the years, there has nonetheless been quite a number of debates over the terminology associated with small group tasks. The term *collaborative learning* has become relatively commonplace to refer to peer-led, small-group activities, group problem-solving, or simply group work; although, its usage and meaning vary between studies and research traditions. While oftentimes considered synonyms (see Dillenbourg, 1999), Damon and Phelps (1989) differentiated two terms—*cooperative learning* versus *collaborative learning*—highlighting how cooperative learning interventions tend to favorize the subdivision of tasks according to members' individual expertise, while collaborative learning interventions emphasize high levels of shared understanding and collective accountability. While, for some, one does not discount the other—for example, Gillies (2014) considers collaborative skills to be

an outcome of cooperative learning—Dillenbourg (1999) suggests that the nuances inherent in the division of labor (e.g., cooperative learning's "jigsaw" method as a contradiction of "genuine" collaboration) justify a terminological distinction. What we know is that both terms are actively used today, and research supports the use of either to the extent that group members "construct and maintain a shared conception of a problem" (Roschelle & Teasley, 1995, p. 70). What's more, interventions that support collaborative problem-solving effectively support and monitor group members' pursuit of collective goals and the mutual understanding of higher-level concepts. This may include some forms of the "jigsaw" method (Aronson, 1978) where lower-level organizational elements are subdivided amongst members, provided that conceptual learning goals are tackled or explored as a group (Brown & Campione, 1996). As argued by Brown and Campione (1996) and others, developing a shared conceptualization of the problem is an essential step in creating a classroom environment that fosters a community of learners.

Peer-led group activities have also been heralded for the potential to provide an interactional context that allows students to critically engage with different perspectives. In some cases, this has been shown to lead to greater group performance. Research has found that when disagreements incite group members to justify their reasoning and bring group members' attention to correct contributions, group problem-solving is more likely to benefit learning (Chiu, 2008). In contrast, when groups refuse to engage with one another's ideas—by, for example, giving simple responses rather than explanations (Webb, 1989) or by ignoring or rejecting a group member's proposals (Barron, 2003)—student performance suffers. Howe and Abedin (2013) stress that the exchange of competing ideas, though arguably a construct widely accepted in Western contexts, remains a key component of many theories of learning.

It has also been argued that peer-led small-group activities engender epistemic-level reflection that may grow students' awareness and appreciation of themselves and others as collective agents (Stahl, 2006). This process is important for students to better understand how disciplinary knowledge is decided upon (Ford & Forman, 2015) and the purpose of collaboration in its development (Damşa et al., 2013). While studies suggest that students' epistemological beliefs might influence how students participate in specific types of dialogue, such as argumentation (Nussbaum & Bendixen, 2003), other studies suggest that participating in small-group activities, accompanied by thoughtful scaffolding of group norms, can help students develop a greater appreciation of working and thinking together (Collins et al., 1989; Nystrand et al., 1997; Yackel et al., 1991). It is important to note that this idea extends beyond motivational aspects of group work. This perspective, along with others addressed within this section on collaborative learning, addresses students' understanding of the value and importance of their contributions and whether students make deliberate efforts to pursue collective goals, an idea which has been conceptualized in relation to students' development of agency (see Omland & Rødnes, 2020).

As research in peer-led collaborative settings multiplies, the case for students' metacognitive engagement also strengthens. The literature suggests that helping students develop the capacity to participate in educational dialogues may help students develop metacognition and self-regulation (Whitebread et al., 2013). Similar perspectives regarding learning in groups posit that learning how to productively participate in educational dialogues helps students become self-reflective, since students are encouraged to think about their own and others' social and communicative processes and how different ways of communicating influence the achievement of collective group goals. Given that self-reflection has proven to be an essential component of

theoretical models of metacognition and self-regulation (Nelson & Narens, 1994), research has suggested that promoting a specific type of communication that encourages self-reflection, such as those promoted through dialogic teaching approaches and pedagogies, hold promise (Fisher, 2007). Some have even suggested that developing students' metacognitive reflection through discussion-based practices may concomitantly build other cognitive capacities needed for related activities, such as self-directed problem-solving (see Mercer, 2013).

Dialogue For Learning, Learning Dialogue: Within and Beyond the ZPD

Being attentive to students' specific learning needs (i.e., students' *zone of proximal development*), including knowing when to begin fading assistance, demands that teachers participate in a learning dialogue with students. Mercer (1994) extended this idea, arguing that students do not simply appropriate teachers' learned practices (i.e., enculturation) but teachers also draw on students' thinking. Here, Mercer made a theoretical link between Vygotsky's conceptualization of learning processes and Bakhtin's concepts of *voice* and *reciprocity*. In effect, teachers draw on students' ideas by "revoicing" (O'Connor & Michaels, 1993), paraphrasing and essentially offering back "a form which is considered by the teacher to be more compatible with the current stream of educational discourse" (Mercer, 1994, p. 105).

However, different educational contexts and cultures have historically made it difficult for students' voices to play a role in the learning dialogue. Cazden and Beck (2003) highlight how, beyond the pragmatic distinction of traditional versus non-traditional lessons (see Edwards & Mercer, 1987; Lemke, 1990; Mehan, 1979; Sinclair & Coulthard, 1975; Wells, 1993), it becomes impossible to ignore the diversity of cultural experiences that students bring with them when they enter into the classroom. The series of papers in Cazden, John, and Hymes (1972) further revealed that, while ostensibly welcoming diversity, there existed nonetheless a lack of

mutual understanding regarding the function of language within the classroom. The silence of students was a salient example of this idea. In other words, researchers realized that certain discursive expectations held by teachers were not fully understood, or shared, by students coming from different cultural backgrounds. This is not to place the teachers' expectations above students' misunderstandings lest one assume a certain superiority of the culture of classroom talk over that of the students' cultures. This is precisely the kind of idea that Cazden rejected, encouraging instead a conceptualization of education that "hybridized" classroom discourse (Cazden & Beck, 2003, p. 189). The challenge was to account for both the different cultures of the students as well as the classroom discourse found in schools, which held an important place in society. Far from being an easily resolved tension, Cazden's research contributed nonetheless to the idea that the way teachers understand and evaluate classroom talk in light of cultural diversity were key to creating inclusive classroom environments necessary for classroom dialogue.

These ideas, however, do not ignore the struggle involved in appropriating educational discourse. Piaget (1932/1965) believed that confronting conflicting perspectives was not just a useful part of learning, but an essential part of learning, though one that happened naturally when children are given the opportunity to interact with the world around them. Subsequently, in his works, Piaget would caution against blindly appropriating the thinking of an authority figure. In Howe and Abedin's (2013) words, Bakhtin's (1981) would even go so far as to claim that "struggling with another's discourse" is at the heart of individuals' development of "ideological consciousness" (p. 348).

Researchers relate this situation to the dialectic–dialogic tensions much debated in the literature on dialogue today (Matusov, 2009; Wegerif, 2013). When examining Socrates'

practice, the famous dialogues as recounted by Plato around the 4th century BCE, Wegerif asserts, "The main problem with dialectical thinking is the illicit assumption of an 'above' perspective or master standpoint outside of any dialogue from which one can know in advance how the dialogue should turn out" (Wegerif, 2013, p. 26). The influential Brazilian educator, Paolo Freire, held a particular commitment to denouncing such "oppressive" practice, as was reflected in his life and his work *Pedagogy of the Oppressed* in 1970. He denounced the "banking" concept of education as an instrument of oppression, characterized by teachers "depositing" information into the brains of children (Freire, 1970/2000, p. 72). Freire argues that "knowledge emerges only through invention and re-invention, through the restless, impatient, continuing, hopeful inquiry human beings pursue in the world, with the world, and with each other" (p. 72). Thus, learning dialogue entails not only a dialogue for learning but dialogue for *being*, which unquestionably has the power to change individuals' understanding of what it means to learn.

Overview of Chapters

As readers embark on the next chapters of this dissertation, I hope that readers will welcome the depth afforded by this qualitative research. As an overview of the chapters to come, Chapter 2 reports on the extant literature on teacher learning in the broader context of dialogue-intensive pedagogies and practices. Chapter 3 provides an overview of the methodology used to investigate teacher learning in the context of collaborative online workshops on dialogic pedagogy. Chapter 4 provides a detailed report of the findings, while Chapter 5 gives a critical discussion of the findings and limitations in relation to relevant literature. Finally, in Chapter 6, this dissertation concludes with a philosophical look at where we may see ourselves going in the future of dialogic education and research.

Chapter 2: Literature Review

Teacher learning is a complex, multifaceted process. This chapter investigates teacher learning processes and how they have been investigated in the literature. What's more, this chapter aims to better understand what we know to date specifically about teachers' learning processes with regards to dialogue-intensive pedagogies, including the cognitive, social, and cultural processes and mechanisms involved in developing dialogic practices across the span of a teacher's career. A systematic scoping review of the literature on teacher learning of dialogue-intensive pedagogies was conducted and emerging findings reported.

Social Constructivist and Sociocultural Perspectives on Learning

Teacher knowledge, beliefs, and practices can change and evolve. However, the manner in which change is conceptualized depends upon the philosophical assumptions guiding the study of knowledge and its evolution or development over time. For example, social constructivist perspectives contend that knowledge entails cognitive domains that are actively (co-)constructed within mediated social practices (O'Donnell, 2012). According to Cobb (1994), these interactionist perspectives are often associated with Piaget's (1970) genetic epistemology, Mehan and Wood's (1975) ethnomethodology, and Blumer's (1969) social interactionism. Sociocultural perspectives, on the other hand, argue that knowledge is foregrounded by and derivative of culture and thus appropriated through meaningful activity (Göncü & Gauvain, 2012). While often considered to be two sides of the same coin, these complementary metaphors (Cobb, 1994; Sfard, 1998) conceptualize changes to knowledge, including teachers' pedagogical knowledge, not as an accumulation of representations in the head, but rather a dynamic, context-dependent system of meaning that becomes personalized through teachers' active participation in socially and culturally valuable activity.

Teacher Knowledge and Learning

Teacher Knowledge and Beliefs

Teachers' pedagogical activity draws on teachers' knowledge and beliefs, whether overtly or covertly. The development of pedagogical knowledge has been conceptualized as one of many elemental and interconnected components of teacher knowledge and learning. Shulman (1986) identified three primary domains of teacher knowledge, content knowledge, pedagogical knowledge, and pedagogical content knowledge. These knowledge domains have been instrumental in advancing understanding on teaching expertise (Berliner, 2006), particularly adaptive expertise (Corno, 2008), and its relationship with student learning. Furthermore, Shulman's work has been applied across multiple domains, including science (Magnusson et al., 1999), mathematics (Ball et al., 2008), and technology (Mishra & Koehler, 2006).

Philosophical and empirical studies have also explored the importance of teachers' *tacit* knowledge (Kelly, 2009) when investigating teacher learning. In their overview of cognitive apprenticeship, Collins and Kapur (2014) associate tacit knowledge with strategic knowledge emerging in the form of heuristic strategies, or "tricks of the trade": "experts apply strategies without being consciously aware of exactly what they are doing" (p. 113). Collins and Kapur acknowledge the shortfalls of overly relying on learners' domain knowledge (i.e., subject-specific content, facts, procedures) and argue that contextualized practice gives learners better clues as to the tacit knowledge inherent in particular tasks and the strategies needed to accomplish them (Brown et al., 1989).

Additionally, research suggests that it is difficult to untangle teachers' knowledge from their beliefs about teaching-and-learning (Munby, 1984; Nespor, 1987; Richardson, 1996). Nespor (1987) argues the following:

> [I]f we are interested in why teachers organize and run classrooms as they do we must pay much more attention to the goals they pursue (which may be multiple, conflicting, and not at all related to optimizing student learning) and to their subjective interpretations of classroom processes. (p. 325)

As with tacit knowledge, teachers' beliefs are also understood to be intimately connected to their context (Brown et al., 1989) and situated within their professional practice (Enyedy et al., 2006). Hence, contextualized practice, within which teachers' tacit knowledge and beliefs are activated, is hypothesized to be essential to the "real-world explanatory value" of research claims, arguably more "meaningfully tied to the world" (Barab, 2014, p. 152).

Mechanisms of Change: Reflection and Action

These broad notions conceptualizing changes in teacher knowledge, beliefs, and practices have undergone critical examination, particularly in research within educational psychology and the learning sciences investigating the mechanisms and factors influencing teacher learning. Across a broad range of philosophical traditions, common roots in the concepts of reflection and action have emerged. Various models of teacher learning have been proposed, largely built around these two mechanisms.

The concepts of reflection and action find their roots in the works of Dewey (1933), Schön (1983, 1987) and Freire (1970/2000). While argued to lack a clear definition of reflection, Dewey's work guides conceptualizations of reflection as a meaning-making process, rooted in systematic, community-based inquiry, and reposing on attitudes respecting one's own and others' intellectual and moral growth (Rodgers, 2002). Schön would ground understandings of teacher knowledge within their practice (i.e., theory-in-action or reflection-in-action), arguing that teacher knowledge is more akin to teacher knowing, situated in the tacit, intuitive,

"epistemic work" (Cook & Brown, 1999) and pedagogical practices that define teachers as experts or novices (Lampert, 2010).

Furthermore, Freire (1970a, 1970b) emphasized the liberating power of the dialectic between reflection and action for learning: "The act of knowing involves a dialectical movement that goes from action to reflection and from reflection upon action to a new action" (Freire, 1970b, p. 213). According to Blackburn (2000), the fusion of theory and action, or praxis, was at the heart of Freire's conceptualization of dialogical education, in which teachers and students become creative authors, rather than passive subjects, of learning. In reaction to these philosophical teachings, teacher education, professional development (PD), and research programs attempt to manage these two philosophically and logistically complex goals as evidenced in the extensive literature on Lesson Study (Lewis & Tsuchida, 1997; Lewis et al., 2006; Widjaja et al., 2017), teacher noticing in video clubs (Santagata, 2011; van Es & Sherin, 2010), collaborative curriculum design (Huizinga et al., 2014; Voogt et al., 2011; Voogt et al., 2016) and more recently in PD on dialogic pedagogy (Mercer et al., 2020).

Other Models of Teacher Learning

Various models of teacher learning have been proposed, broadly implicating reflection and action, but also teachers' ideals and values, personal factors, dialogical factors, and cultural factors. I give a brief overview of some of the models that have been proposed to represent a wider breadth of philosophical traditions (e.g., cognitivist, sociocultural, participatory). While the following overview is not exhaustive, these models allow us to begin delving into the various components that are hypothesized to explain the processes and components underlying teacher learning processes.

One of the widely cited models of teacher change was developed by Clarke and Hollingsworth (2002). Their *Interconnected Model of Teacher Professional Growth* integrates four domains of the "teacher's world" which include: "the personal domain (teacher knowledge, beliefs, and attitudes), the domain of practice (professional experimentation), the domain of consequence (salient outcomes), and the external domain (sources of information, stimulus or support)" (Clarke & Hollingsworth, 2002, p. 950). In building toward their model, Clarke and Hollingsworth highlighted four major issues at play in the empirical literature: (a) in some cases, evidence of student change was an essential prerequisite before teachers' beliefs or knowledge would change (see Cobb et al., 1990; Guskey, 1986); (b) change was not just practice-based but also involved a "cognitive conflict" (Cobb et al., 1990; Johnson & Owen, 1986); (c) that these processes were not linear; and (d) that these processes had to be embedded in authentic school and classroom practices so that teachers had a chance to integrate new behaviors into practice. Consequently, Clarke and Hollingsworth depict how their four domains are mediated by iterative, or cyclic, processes of reflection and enactment, situated within the "change environment" (Hollingsworth, 1999).

Teachers' ideals and values have been hypothesized to play a fundamental role in the progression of reflection. Korthagen (2017) argues that reflection is necessarily embedded in personal sense-making, described as triggering individual teachers' gestalts through experience. In so doing, Korthagen highlights first and foremost the unconscious dimensions guiding teachers' behavior, that is, the cognitive, affective, and motivational dimensions influenced by the social environment in which teachers learn and practice. Korthagen draws on different cognitive and motivational theories of learning, for example Self-Determination Theory (Deci & Ryan, 2002) and an emphasis on teachers' ideals (De Ruyter & Kole, 2010; Newman, 2000; see

also Palmer, 2017). Korthagen also argues that this conceptualization of teacher learning greatly challenges the viability of standardized modes of PD that aim to establish a set characteristic of "good teaching" (p. 393). Korthagen offers a progression of reflection for teachers' own reflective practice, beginning with reflection on one's context, then deeply examining their personal goals and motives. Teachers are encouraged to reflect on how these affected their actions and subsequently student learning. Drawing on the works of Hoekstra (2007) and Mansvelder-Longayroux et al. (2007), Korthagen associates this process of self-assessment with "meaning-oriented reflection" (in contrast to "action-oriented reflection") in that reflection encourages teachers to better understand underlying processes. Korthagen (2017) uses an "onion model" to depict the multi-level layers of reflection.

Personal factors have also been identified in recent literature, including teachers' capacity to regulate their learning. Vermunt and Endedijk (2011) propose a model that endeavours to bridge the knowledge built around student learning (school and university) and teacher learning to create what they argue to be a more scientifically rich model. Their model is argued to expand further the "covert (mental)" and the "overt" activity of learning. Vermunt and Endedijk hypothesize that teachers' beliefs, motivations, and capacity to regulate their own learning are distinct but interconnected components influencing teachers' teaching and learning activities. Additionally, Vermunt and Endedijk propose that these interconnected components are moderated by personal factors (e.g., personality, experiences) and contextual factors (e.g., formal or informal learning environments, peer coaching, professional learning communities). Lewis et al. (2015) also present self-regulation as part of their model, along with other cognitive, social, and school culture factors. Like Vermunt and Endedijk, they too avoid the question of

interrelationships, presenting instead a Venn diagram showing a general interconnectedness between the different components.

Dialogical factors have also arisen. Research has investigated different ways to bring together teachers from different grade levels, subject areas, and schools to collectively reflect on issues of student learning and, in so doing, explore teachers' shared capacity to coordinate pedagogical observations, contradictions, and future activity. Warwick et al. (2016) build on a sociocultural perspective to investigate the dialogical factors inherent in teacher learning discussions within Lesson Study. Drawing on Vermunt and Endedijk's (2011) model, Warwick et al. found that teachers' Lesson Study activity, and in particular the development of teachers' pedagogical intentions, reposed on the 'dialogic space' created during teachers' reflective discussions. Despite the fact that participating teachers came from different teaching contexts (different grade levels, different schools), when discussions centred on teachers' observations of students' strategies or outcomes in a supportive way, teachers were able to extrapolate generalized understandings of student learning, leading to agreement on future pedagogical activity.

In some studies, acknowledging cultural differences was an essential factor in understanding teachers' practices and learning (e.g., McConney, 2013). Zheng et al. (2019) highlight the need for teachers from historically collectivist cultures like China to have opportunities to face genuine tensions that prevent teachers from participating in "superficial harmony" or face-saving behaviors (Zheng et al., 2016). Without the opportunity to observe more skilled teachers or to observe teachers from other subject areas, teachers may not perceive the learning potential (Zheng et al., 2019). To effectively draw on these differences, however,

teachers needed to acknowledge the need for PD; to be autonomous and motivated to put in the effort needed for change; and to have the capacity to reflect on past, current, and future practice.

Zheng et al.'s (2019) observations speak not only to the individual capacity but also to a collectively built capacity through expert teachers' positions as "role models" and "moral models". In parallel, Zheng et al. affirm the need for expert teachers to develop "boundary crossing competence" to ensure that teacher learning is optimized within these complex boundary crossing spaces. Consequently, teachers' comfort and capacity to critically challenge their colleagues' ideas also proves to be an important factor in ensuring that teachers continually improve their practice (Males et al., 2010). As Males et al. (2010) show in their study with mathematics teachers, criticality appears to be related to the critical distance afforded by collaborative activities. For example, Males et al. noted more criticality when teachers critiqued ideas in an article than when discussing one's own or their colleagues' lived classroom experiences, in which case face saving behaviors were observed.

Learning Dialogue-Intensive Pedagogical Knowledge and Practices

To date, researchers are still developing theories explaining how teachers learn, including how teachers develop their pedagogical positioning. Intimately linked to teachers' philosophies of teaching-and-learning, pedagogical positioning includes teaching behaviors that are indicative of particular pedagogies or pedagogical beliefs. However, pedagogical positioning does not have clear-cut boundaries that can be easily delimited and targeted by PD initiatives. Thus, while the evidence provided for each of the learning components explicated above is compelling, researchers admit that the interrelationships need further clarification (Lewis et al., 2015; Vermunt & Endedijk, 2011). Vermunt and Endedijk also argue that these learning patterns need to be examined in light of specific pedagogical approaches. Not only does this idea draw our

attention to ‘how’ teachers develop dialogue-intensive pedagogies, but it also gives us another avenue into exploring why, in some cases, teachers’ practices remain distanced from dialogic approaches even after pedagogical development and training (Howe & Mercer, 2017).

Dialogue-intensive pedagogies (Wilkinson et al., 2015) include dialogic pedagogy, dialogic teaching, and other teaching-and-learning practices that aim to help students develop the capacity to participate in educational dialogues (Baker, 2020; Kim & Wilkinson, 2019). Building on the philosophical notion of dialogism (Bakhtin, 1981), students are given opportunities to share their developing knowledge and to make sense of different perspectives, oftentimes through peer-led, small-group activities and thoughtfully facilitated whole-class discussions (Mercer & Littleton, 2007). With the guidance of teachers, students may be led to reconcile differences between everyday knowledge and formal, school knowledge (Boyd & Smyntek-Gworek, 2012; Nystrand et al., 1997). This includes developing an accountability to reasoning and scientific principles (Michaels et al., 2008; Mortimer & Scott, 2003). In some instances, dialogic teaching also draws explicit attention to metacognitive components (Mercer, 2013; Reznitskaya & Gregory, 2013; Wells, 1999), where carefully scaffolded activities (Bakker et al., 2015; Jones, 2007; Muhonen et al., 2016; Perry, 2013; Rojas-Drummond et al., 2013) are argued to promote high-level thinking processes necessary for deeper level learning (e.g., self-regulated learning) (Whitebread et al., 2013). In all these cases, teachers draw students’ attention to classroom interactions and, specifically, the language used to learn together. In so doing, students’ curiosity is piqued, and their creativity challenged, as they learn how to recognize, interact with, and respond to different perspectives.

While research suggests that dialogic teaching offers multiple benefits for student learning across subjects (Boyd & Markarian, 2011; Chinn et al., 2001; Mercer & Littleton, 2007;

Nystrand et al., 2003; Resnick et al., 2015; Walsh, 2002), dialogic teaching and dialogue-intensive pedagogies more broadly remain on the margins of practice (Howe & Abedin, 2013; Howe & Mercer, 2017). Howe and Mercer (2017) venture to give three explanations for why dialogic teaching remains on the margin of practice. First, it is possible that dialogic teaching has been oversimplified. Howe and Mercer (2017) observe that in some studies (Lin & Lo, 2017; Wilkinson et al., 2017), teacher–student interactions described did not quite add up to what they would call dialogic, or dialogical, suggesting that dialogic teaching might have been reduced to one of many teaching approaches and adopted only in those subject matters in which dialogic practices were more easily incorporated into the existing curriculum. Flanders (1970) described behaviors by which teachers, rather than learning how to be "purposeful", might consider such new approaches as a list of strategies that "need only be understood and added to the repertoire" (pp. 18-19). In this scenario, if dialogic teaching is perceived as more readily adopted in subject areas such as literacy where multiple perspectives are more easily shared and adopted, in contrast to other disciplines such as mathematics where the emphasis on rigor and precision appear to be at odds with some of the critical features of dialogic pedagogy, such as exchanging multiple perspectives (see Sfard, 2015, 2020), dialogic teaching might indeed lose its interdisciplinary appeal. In this case, it would be preferable that pedagogical development programs help teachers integrate a pedagogical framework that integrates both theoretical and practical knowledge (Reznitskaya & Gregory, 2013).

Secondly, Howe and Mercer (2017) propose a "'hierarchy of approximations' to dialogicality" which might better explain, or model, the processes by which dialogic teaching is effectively adopted (see Grossman et al., 2009 for more on "approximations of practice"). Here, we understand that such a model might track teachers' development toward more mature models

of dialogicality. By understanding dialogic teaching as an expression of dialogic pedagogy, conceptual coherence is created in what otherwise might be relegated to a panoply of discussion strategies. Nonetheless, two related sub-issues stand out: on one hand, identifying which of the dialogic teaching practices appear to be adopted more readily considering teachers' current practices; and, on the other hand, understanding how to ensure that teachers' development of dialogic teaching is not prematurely foreclosed at the first appearance of challenging features.

Thirdly, Howe and Mercer (2017) argue that inconsistency in dialogic teaching's definition and other related conceptual terms reflects the unfortunate possibility that research might inadvertently divert attention away from core ideas and questions on learning concerns. Not only do Howe, Mercer, and others (Asterhan et al., 2020; Sfard, 2015) argue that this idea is paramount for assessing the relationship between dialogic teaching and student learning, they emphasize that clarity is essential for conceptual growth in the field.

Literature Review Method

To gain more conceptual clarity, this review delves into the literature on dialogic pedagogy, dialogic teaching, and dialogue-based practices more broadly, to better understand the processes and mechanisms underlying how teachers learn dialogue-intensive pedagogies.

Search Criteria

Search key terms related to teacher learning were drawn from Postholm's (2012) theoretical review of teacher professional development and learning. The teacher learning search string included the following: ["teacher learning" OR "professional development" OR "teacher development"]. These search terms aligned with the context and objectives of this study. They were also found to be broad enough to capture a variety of literature across the trajectory of a teacher's career.

To reduce the scope of teacher learning specifically to literature on dialogue-intensive pedagogies, search terms drew on Kim and Wilkinson's (2019) theoretical review of dialogic teaching and pedagogy. The dialogic search string included the following: ["dialogic teaching" OR "dialogic pedagogy" OR "dialogic education" OR "dialogic inquiry" OR "dialogic method" OR "dialogically organized instruction" OR "collaborative reasoning" OR "thinking together" OR "inquiry dialogue" OR "accountable talk" OR "productive dialogue"]. Because there is not consensus on terminology associated with dialogue-intensive pedagogies, one additional keyword was added to this string, namely "classroom discourse" (again, separated by the Boolean operator "OR"), which was deemed to reflect a broader spectrum of approaches aligned with social constructivist, sociocultural, and dialogic philosophical orientations.

Both teacher learning and dialogic pedagogy search strings were separated by the Boolean operator "AND" and ran through the databases PsycINFO and ERIC (see Appendix A, Table A1). The search (as well as the theoretical overview described above) took place in December 2021 after my final phase of grounded theory modelling began to stabilize, as is standard procedure in a grounded theory approach (Glaser & Strauss, 1967) (see Chapter 3: Methodology). Combined search results in PsycINFO and ERIC came to 274 hits, which were imported into EndNote X9.3.3 for duplicate removal. After duplicates were removed, 221 research papers were included for screening.

Screening Process

During the screening process, titles and abstracts were read to ensure that the research papers met the basic selection criteria: (a) took place in the context of basic education/K-12; (b) concerned teacher learning/PD; (c) specifically or broadly focusing on dialogic, discourse-focused, or dialogue-intensive pedagogies; and (d) were written in English or French. After the

screening process, 141 research papers were retained. Their abstracts were re-read with greater attention, necessitating in some instances a rapid full-text read-through to verify adherence to the basic inclusion/exclusion criteria. This step led to the exclusion of an additional 47 papers. Thus, 94 research papers passed to the full-text eligibility screening. Motives for rejection can be found in Appendix A (Table A2).

Out of the 94 full texts, research papers were included in the final selection if they empirically investigated one or multiple facets of teacher learning, and particularly if they had the potential to explain the "why" of teacher adoption (or non-adoption) of dialogic, discourse-focused, dialogue-intensive pedagogies based on the empirical evidence presented. A total of 63 empirical studies were included in this review.

Outcome of Selection Process

Amongst the 63 research papers included, about one-fifth (21%) were published between 2002-2011, and over three quarters (78%) between 2012-2021, revealing this topic to be a relatively recent but growing one. Most studies were empirical articles from peer-reviewed journals (n = 44). This sampling also included a non-negligible number of doctoral dissertations (n = 16). Three articles resembled empirical research reports. More than 15 countries/regions are represented in this literature sampling, with over half (56%) of the studies from the United States (see Appendix A, Table A3). Two subject matters stand out in this sampling of the literature: science (27%) and mathematics (24%) (see Appendix A, Table A4). Science was similarly represented in this sampling when compared to similar reviews (Howe & Abedin, 2013), although mathematics contexts were proportionally higher in comparison. The proportion of studies taking place in secondary contexts also appears to be higher in this sampling of the

literature when compared to similar reviews (Bae et al., 2021; Howe & Abedin, 2013) (see Appendix A, Table A5).

Literature Review Results

Professional Development on Dialogue-Intensive Pedagogies

As projected, literature investigating research-based professional development on dialogue-intensive pedagogies (PDDP) shared several elements. Most importantly, the literature on PDDP conveyed the importance of and strategies for promoting a culture of talk in teachers' classrooms and schools (Anderson et al., 2018; Borko et al., 2021; Disney, 2016). Consequently, PDDP paid special attention to the language that teachers use in the classroom and its relationship to students' learning and success in academic contexts (Flitton & Warwick, 2013; Gilliland, 2012). PDDP also aimed to leverage principled teaching-and-learning activity based on the concepts of dialogue (Hennessy et al., 2011), supported through reflective activities situated in teachers' professional practice (Borko et al., 2021).

Research on PDDP also increasingly focuses on ways to ensure that teachers can practice their agency. Teachers were conceptualized as experts of their own classroom, with student learning taking centre stage as the ultimate goal of PD (Westgate & Hughes, 2016). What's more, materials often encouraged teachers' ownership of the PD materials by allowing teachers to use and adapt research-based resources to their own classroom contexts. PDDP also trained teachers to take a "research stance" (Stenhouse, 1975, cited in Hennessy et al., 2011, p. 1916). For example, examples of PDDP have provided teachers with research-based tools to observe and reflect on their own language use for pedagogic purposes (Aşık & Kuru Gönen, 2016) critically and systematically.

Congruent with its underlying dialogical ontology, PDDP aims to promote dialogic interactions between teachers, researchers, and other educational stakeholders as they learn about dialogue-intensive pedagogies together. PDDP that fully embody this dialogical ontology often entail non-directive collective sense-making. Research reveals how this open mode of coinquiry may seem confusing for teachers unacquainted with genuinely collaborative modes (Wallen & Tormey, 2019), but which arguably provide teachers with the necessary dialogic space to confront the difficulties and challenges that might otherwise be masked by step-by-step procedures.

The investigation of teachers' development of dialogue-intensive pedagogies was not always embedded in a formal professional development (PD) initiative. For example, there were some studies in which conversations, classroom observations, and interviews with the researcher led to deeper understanding of teacher learning without necessarily taking the form of a formal PD initiative (e.g., Bomphray, 2018). These forms of analysis also proved to be valuable for understanding different facets of teachers' development of dialogic pedagogy, whether taking place individually or in groups of teacher teams.

Material- and Technology-Supported Professional Development

To support a situated orientation to teachers' learning, research tends to favor the provision of materials and activities that can equip teachers with tools that they can use to try out new dialogic pedagogical approaches with their students (see Hennessy et al., 2011; Larrain et al., 2017; McKeown & Beck, 2004). It could also be argued that these tools can open up new opportunities for teachers to explore the alignment of tasks, curricular goals, and the dialogue that connects them, by exploring the material-dialogic spaces (Hetherington & Wegerif, 2018) that emerge when teachers use or adapt research-based materials. According to Hetherington and

Wegerif (2018), a material-dialogic approach envisions the full potential of material resources, including digital technologies, in teaching-and-learning activity for connecting practical work with dialogue and thus to intellectual development, which unfortunately is not always realized in classrooms (see Anderson et al., 2018; Bloomfield, 2016).

In parallel, PDDP also supports teachers' reflective practices through technology-supported activities. Often involving video-based PD activities, technology-supported reflective tasks have been argued to be an essential component of ensuring that teachers develop the capacity to critically reflect on their own and others' classroom dialogue (Borko et al., 2021; Flitton & Warwick, 2013; Hennessy et al., 2011; Hennessy et al., 2018). While multiple studies include a technology-centred (e.g., video reflection) or blended approach (i.e., combination of online and face-to-face activities) to the research-based PD (Chen et al., 2020; van de Pol et al., 2017), in this sampling of the literature, only two studies took place solely online (Matsumura et al., 2019; Perry et al., 2020).

Teachers' Pedagogical Knowledge and (Mis)Aligned Beliefs About Knowledge Construction

Before teachers learn about dialogue-intensive approaches, research reveals the importance of investigating teachers' current knowledge and beliefs about knowledge construction. In investigating teachers' conceptualization and use of, for example, constructivist terminology, research has found that teachers may already have a very rich and, in some cases, a very stable understanding of dialogue-based pedagogy. Waymouth (2020) found that science teachers participating in a study on sensemaking-oriented instruction held conceptualizations of sensemaking indicative of a social constructivist philosophical stance at the outset of the study. Teachers described intervention materials and concepts as synonyms of constructivism, or an old idea packaged in a new way. Elsewhere, mathematics teachers also understood a literacy-based

PD program related to discourse as simply “just the basic math curriculum” and further equated it to “how I’m teaching math” (Colonis, 2011).

In unpacking these understandings of dialogue-intensive terminology and its relationship to teachers’ pedagogical practices, researchers have found that teachers’ espoused pedagogical positioning may be in contradiction with their actual practices (Argyris, 1976; Biggs, 1996; Kagumba, 2015; Kubanyiova, 2015; Murphy et al., 2018). In studies with Ugandan science teachers (Kagumba, 2015) and Qatari mathematics and science teachers (Murphy et al., 2018), teachers reported positive views and aspirations aligned with constructivist or inquiry-based approaches. However, further analyses of knowledge, beliefs, and practices revealed teacher-centred (Murphy et al., 2018) and objectivist (Kagumba, 2015) pedagogies that might underestimate the effect of theory-laden observations or subjectivity on scientific knowledge construction (Kagumba, 2015; Kilinc et al., 2017). On the other hand, teachers may also overestimate the effect of subjectivity on knowledge construction (Wilkinson et al., 2017). Wilkinson et al. (2017) found that, throughout the course of an intensive PD program in the US, language arts teachers’ practices changed, but their epistemological beliefs did not evolve from their initial subjective stance, characterized by the belief that arguments, the use of reasons, and evidence are unique and thus unqualifiable in terms of truth.

Furthermore, even when teachers’ knowledge and perspectives on discourse-rich approaches and practices reportedly improved (i.e., aligned with research-based conceptualizations), this did not translate to practice. For example, Edmondson and Choudhry (2018) conducted a qualitative study with 120 elementary teachers. After teachers participated in a professional development program highlighting the importance of teacher and student discourse in science education, teachers described how they planned on using the discourse-

oriented strategies within the upcoming academic year. Specifically, teachers mentioned the use of norms and classroom expectations for talk, including the talk prompts provided in the professional development program. Other note-worthy take-aways included a general increased awareness of the importance of classroom talk and student interactions across subject areas as well as strategies to increase student interactions in their classrooms. While the authors further describe an awareness on the part of the teachers of the change in roles needed in their own instruction and the participation of their students, this increased appreciation for discourse did not however translate to a significant change in teachers' science instruction strategies. In fact, researchers more often observed instances where teachers aimed to maintain a tight control of student interactions. Kubanyiova (2015) associates teachers' control and authority with teachers' complex "possible selves" and argues that these identities may lead teachers to view discussion-rich approaches as simply a springboard to the "real" teaching and learning (p. 576).

Novice Versus Veteran Teacher Beliefs on Adopting Dialogue-Intensive Pedagogies

Research reveals that these beliefs begin early in teachers' education and careers, many of which are influenced by teachers' own experiences when they were students (Darling-Hammond & Bransford, 2005). In a university content area reading course (Holt-Reynolds, 1991), when presented with the recommendation that teachers favor small-group, peer-led discussions over frontal, direct lecture-style teaching, preservice teachers (PSTs) rejected the notion that lectures encouraged passive student behaviors, arguing that active listening was just as valuable an activity for student learning. Peer-led, small-group activities, typical of constructivist pedagogical approaches, may prove to be a particularly difficult point to address for early career teachers. These strategies seem to transpire in PSTs own classroom discourse as they interact with one another and their university instructors (Kelly, 2010). As Kelly (2010)

observes, PSTs found greater value in discourse-centred approaches when they felt that they had adequate opportunities to explore their own identities as PSTs through discourse. PSTs who did not feel that they had a reasonable amount of time to participate in useful discourse conveyed indecision about its value and subsequently hesitated to embrace discourse-rich approaches. Despite these findings, research suggests that personality might be a non-negligible factor that influences PSTs' initial perspectives on discussion-based practices (Kilinc et al., 2017).

Rather than focus on expertise as a function of years of teaching experience, Hennessy et al. (2011) focused instead on observable evidence that participating teachers already had a dialogic pedagogical approach. Cross-case analyses revealed three emergent motivational factors contributing to teachers' successful coinquiry activities on dialogic pedagogy, namely that (a) teachers were receptive to scholarly theory, were willing to share and change their beliefs, and desired to grow their dialogic pedagogy (see also Meyer, 2016); (b) teachers shared a strong mutual interest in learning across research-practice boundaries; and (c) teachers were vested in the goals of the coinquiry program and its relevance to other classes and subject matters (see also Disney, 2016).

Designing Research for Action and Reflection on Dialogue-Intensive Pedagogies

Classroom-Based Reflection and Noticing Activities. Different types of enactment, reflection, and noticing activities primarily based on teachers' classroom practices were afforded by the studies included in this review. Oftentimes, studies prioritized processes of classroom implementation, followed by reflection, and then reapplication of new knowledge and practices in classrooms (Rumenapp, 2016; Seymour & Lehrer, 2006). For example, when given the opportunity to reflect on their mathematical discourse with students, secondary math teachers acknowledged a need to move toward more open discussion prompts (Cavanna, 2014). As

Cavanna recounts, teachers realized that, while intending to guide students, they may have been too directive to allow students' development of a flexible understanding of mathematical concepts. They also recognized that their positive evaluations of student responses were causing students to wait for teacher validation, which inadvertently led to IRE patterns of discourse.

Teachers' enactment processes were often accompanied by research-based strategies for encouraging high quality classroom discourse. McAneny (2013) recounts how awareness gained through a professional development initiative focusing on teachers' discursive practices in the mathematics classroom allowed teachers to better assist students' use of mathematical terminology, thus contributing to a more mathematically-sound classroom culture. In the same study, teachers even recounted instances when their students began to spontaneously explain their mathematical strategies, which the teacher had not observed before using the discourse moves. While students appeared to gain more autonomy, teachers also seemed to change their expectations of students, expecting students to take more ownership of their mathematical learning.

Video-supported reflection was also a common teacher learning activity (Chen et al., 2020; Matsumura et al., 2019; Perry et al., 2020; Sedova et al., 2016; Seymour & Lehrer, 2006; Zhang et al., 2010). Teachers often focus on students but may also choose to focus on their own or others' teaching practices. For example, an interactive video visualization tool allowed secondary math teachers to provide concrete examples of their own and their colleagues' use of target teacher moves and the reasoning behind implementing changes to their classroom discourse (Chen et al., 2020). These segments may be selected by a more expert "coach" (Matsumura et al., 2019) or by the teachers themselves (Vrikki et al., 2021). Vrikki et al. (2021) describe how teachers often showed clips from their classrooms of effective implementation,

although one teacher focused on struggles that he had faced while trying to maintain the dialogic focus in his geography lesson. Watching recordings of their own classrooms proved helpful in allowing teachers to pay more careful attention to their classroom discourse and specifically their own questioning practices (Zhang et al., 2010); to assess the efficacy of their discourse on students' progress (McAneny, 2013), and to engage in more purposeful planning and assessment toward curricular goals (Sezen, 2011; Zhang et al., 2010).

Theoretical and Methodological Conundrums. In analyzing the literature, the mechanisms of change toward a more dialogic pedagogy remained elusive. Despite research's emphasis on teachers' practice, Glazier's (2005) observations of two focal English teachers revealed that some teachers do not need to enact anything before understanding the need for change and subsequently taking action. In this case, research-facilitated discussions on teachers' positionality sparked one teacher's awareness of a need to change her practices to better accommodate the lived, multicultural experiences of her students. In Perry et al.'s (2020) study on teachers' use of oral feedback practices and dialogic teaching, teachers across multiple disciplines received extensive resources, but without any significant change in practice. For example, pre-/postintervention surveys and video-taped lessons did not reveal significant differences between the video club professional development group and the comparison group of teachers (Perry et al., 2020). While the authors suggest that the inconclusive results are due to in part the novel instrument aiming to measure teachers' change in thinking and practice via teachers' self-reported feedback principles, they also point to the complexity of the environment in which the professional development takes place. In the case of Perry et al., teachers were given access to videos and pedagogical resources via a new online platform; however, detailed implementation was handled by the teachers' schools. Perry et al.'s remark reflects that of

Melville (2008), who reiterated that schools may publicly acknowledge adoption of approaches, while data shows the opposite reality.

Also, research suggests that positive changes in practice occur when beliefs are aligned with the underlying philosophical assumptions. Wilkinson et al. (2017) found that regular discussions and co-planning meetings with an expert on classroom discourse appeared to have aided teachers to align practices with the research-based argumentation standards (i.e., ART) (Wilkinson et al., 2017). However, and as seen elsewhere (Larrain et al., 2017), teachers' epistemological beliefs did not change in consequence. It is possible that the heavily supported intensive PD described in Wilkinson et al. (2017) might have made it difficult if not impossible for teachers to get ample opportunity to freely explore their own preconceptions, which might explain the change in practice but the lack of change in teachers' epistemological beliefs.

On the other side, epistemological change may not be a prerequisite for some teachers to modify their practice, as pragmatic methods have proven equally effective. For example, teachers' ritual participation and rule-following might motivate a shift toward discussion-rich methods that benefit math instruction, as demonstrated by Heyd-Metzuyanim et al.'s (2019) study. Only when teachers attempted these practices over several iterations and observed the positive impacts on their students' progress that teachers' practices gradually evolved toward more discussion-rich approaches. This pragmatic perspective to teachers' learning asserts nonetheless the need for teachers to trust that research-based discussion-rich approaches are worth pursuing (e.g., professional curiosity). However, Heyd-Metzuyanim et al. argue that the conviction of their worth comes later after evidence of its efficacity are observed in teachers' own lived experiences in their classrooms.

Contextual factors, particularly those related to curricular reforms or other environmental stressors, may also play an important role as teachers get used to new classroom environments. As science classroom contexts shifted from in-door to out-door environments, teachers whose practices were normally characterized as dialogic became more controlling and authoritative (Glackin, 2018). Glackin argues that it is only when new normalized routines and surveillance strategies were established between teachers and students that teachers' fear of losing control or feeling observed were mitigated, thus allowing some of the teachers to regain a dialogic approach whilst teaching outdoors. However, getting comfortable using dialogic practices in outdoor settings took time, as observed in three of the teachers' practices during the second year of pedagogical development with outdoor teaching.

Given these contrasting examples, it is no surprise that focusing on reflection and action alone would unjustifiably minimize the scope needed to better understand teacher learning processes.

The Unclear Relative Benefit of Working with Other Teachers. In many cases, teachers reflected with colleagues in the same or different schools or districts, discussing with and in some cases receiving direct support from content experts, researchers, and educational leaders. In addition to video-supported reflection described above, collaborative formats also included professional book clubs (Colonis, 2011; Waymouth, 2020); co-teaching and classroom observation (Sezen, 2011); co-planning and follow-up coinquiry and reflection (Sedova et al., 2016; Waymouth, 2020; Wilkinson et al., 2017).

Collegial exchanges and personalized support from experts have both been initially suspected to be mutually beneficial for teachers' development of dialogic practices (see Sedova et al., 2016). However, studies appear to increasingly suggest that collegiality was not as

impactful as reflecting on one's own class and then changing in consequence (Crawford, 2015; Rumenapp, 2016; Zhang et al., 2010). In a follow-up case study, Sedova (2017b) found that the personalized video-stimulated reflective conversations provided by the researcher appeared to be the more significant support mechanism for teacher reflection than the collegial exchanges. Nevertheless, the change processes appeared to be more complex (Sedova, 2017a).

Video-supported self-reflection (Aşık & Kuru Gönen, 2016), personalized researcher-teacher meetings (Sezen, 2011), and onsite personal training (Ashley, 2016; Lam, 2021) allowed teachers, all experience levels combined, to monitor their progression toward more advanced targeted discourse practices. Additionally, two different studies revealed a parallel between the dialogic facilitation processes led by an instructional coach or content expert and the teacher's increasingly dialogic classroom pedagogy (Haddy, 2008; Haneda et al., 2017). Haddy (2008) portrays these processes as a co-learning process, whereby the expert and teacher interactions transform into a collegial relationship wherein teachers can safely confront their learning needs. Far from a hands-free approach, these resource-intensive processes entailed personal goal setting, explicit instruction, and guidance from the expert, as well as time to discuss necessary changes and their rationale.

It may be that collaboration and expert support need to happen in parallel. Researchers found that comparing experiences with one's colleagues via post-implementation follow-up meetings was a valuable reflective mechanism for teachers (Chen et al., 2020; McAneny, 2013). Given the teachers' descriptions of these meetings, it appeared that discussing shared experiences with their colleagues had a cathartic effect for teachers, reassuring them when difficulties were met and challenging them to implement the new discursive techniques. Though not expressly included in this review, a study conducted by Clark (2009) also revealed how the community

created by collaborating with a group of early career teachers provided beginner teachers opportunities to share the highs and lows of their experiences becoming more inquiry-focused in their practice. Yet, Waymouth (2020) cautions these findings, suggesting the possibility that some teachers might not (fully) share what they do in the classroom to save face (e.g., avoid appearance of bragging).

Preconceptions of Student Learning, Ability, Personality, and Motivation

Furthermore, teachers may also carry with them categorical understandings of how students learn, which may be put into question when participating in research-based PD on dialogic pedagogy. For example, teachers may believe that students are natural discoverers (Zhang et al., 2010). This belief was put into question when teachers realized, through video-supported reflection (Vrikki et al., 2021; Zhang et al., 2010) and professional book discussions (Waymouth, 2020), that students needed more guidance. For example, Vrikki et al. (2021) recount how one of the teachers expected that students would take up group norms more readily. In examples of his exchanges with the other teachers and researcher, the teacher describes how he expected students to challenge one another and deepen their thinking, which was not the case. Students simply shared their ideas in groups. He reflects on students' age (lack of maturity) as a possible factor. Even after giving students roles to help guide their communication, reflection on video clips led the teacher to conclude that teachers might need to break down the group norms into more manageable chunks. The researcher acknowledges the support that students need during dialogue-rich activities saying, "Because again, I think I've underestimated the amount of direction and support they need in order to be on it when they're working independently" (Vrikki et al., 2021, p. 402). Both the researcher and teachers agree that more probing questions and prompting might be necessary to clarify the purpose to students' talk.

Studies revealed that oftentimes, teachers' perception of or expectations regarding students' ability, personality, or motivation influences teachers' curricular decision-making and particularly whether and how to implement discussion-rich approaches (Gilliland, 2012; McAneny, 2013; Murphy et al., 2018; Polojac-Chenoweth, 2020). Murphy et al. (2018) found that math and science teachers associated inquiry-based practices with only certain types of students, including high-achieving or innately motivated students or with others seemingly possessing some other innate abilities (e.g., creativity). Student maturity was again a factor in teachers' conceptualization of the viability of inquiry-based approaches in math and science. McAneny (2013) also found that mathematics teachers enacting targeted discursive practices (i.e., Teacher Discourse Moves) tended to focus on high-ability groups, fearing that students in the lower ability groups did not have the capacity necessary to participate in the peer-led practices (e.g., lack of attention span, general lack of math knowledge). It appeared that teachers prioritized classrooms in which it would be "easier to deal with". Not surprisingly, this appeared to influence teachers' grouping decisions as well, prioritizing groupings of students who were more likely to productively engage with the activity.

Teachers may alternatively try to attend to socioemotional difficulties that some students, particularly struggling students, may experience when participating in dialogue-intensive practices. When middle school science teachers used informal verbal feedback to encourage participation from students with disabilities, teachers made the decision to foreclose discussions when students seemed uncomfortable (Sezen, 2011). In another study, teachers were observed taking a more proactive stance when faced with "shy" personalities or a general lack of engagement during whole-group discussions (Rumenapp, 2016). For example, Rumenapp (2016) reports how one EFL/bilingual teacher went so far as to impose "speaking grades" (i.e., grades

for responding to class discussions) to counteract the general classroom silence, contributing to teacher-directive (and arguably less dialogic) classroom interactions. Lloyd's (2008) interpretive case study of an experienced math teacher's implementation of discussion-rich approaches revealed that the focal teacher's (Mr. Allen) perception of student resistance appeared to influence the instructional decisions he made, even going so far as to make adjustments to his instruction that were in opposition with the intentions of the curriculum designers, in an effort to provide instructional practices more closely aligned with his perceptions of students' expectations.

Indeed, teachers may not fully trust that dialogue-intensive practices will be useful for struggling students. A Finnish lower-secondary mathematics teacher applying more authoritative practices cites the structure of mathematics as a potential roadblock for struggling students (e.g., students who have issues concentrating), justifying her use of directive practices to prevent students from getting lost. This teacher's practices were further reinforced by beliefs that her struggling students' talk would get off-task if given a group activity. These studies caution that preconception about struggling students' ability or willingness to engage may not only inadvertently prevent students from learning by limiting access to high-quality instructional practices (Lewis et al., 2015; Lloyd, 2008), but they may also foreclose teachers' learning opportunities by maintaining the status quo of comfort and routine (Lloyd, 2008).

Shifts in Teacher Identity: An Emotional Rollercoaster

For many teachers, the idea of changing to more dialogue-intensive approaches was accompanied by apprehension and hesitancy. For example, in Curtis et al.'s (2020) study, a one-year professional development program on Philosophical Inquiry provided in-depth training to four secondary teachers on how to support students as they learn how to discuss different

viewpoints with one another on a variety of philosophical themes. At the outset of the program, teachers openly shared their concern regarding their own tendency toward control and fearing their inability to let students direct the conversation. Some of the teachers were not overly optimistic of the changes the program entailed and related feelings of anxiety. Similarly, in McAneny's (2013) rich phenomenological study, middle school mathematics teachers expressed concern that it was not clear how much of the PD resources were meant to be completed. This coupled with teachers' observation that the Teacher Moves were also intentionally non-directive created a certain sense of uneasiness with some of the participating teachers. There were even concerns that teachers would lose control of the classroom as more open discourse moves were implemented. Some teachers also brought up the concern that others' perception of their control would be put into question if their classroom became noisy with, for example, more peer-led talk. This was a source of anxiety for some.

In contrast, other teachers found PD programs that encouraged dialogue-intensive principles and approaches to be affirming. Some teachers acknowledged the potential of programs encouraging a dialogical philosophy to help them learn as teachers (e.g., changing practice, developing greater awareness of what they say in the classroom) (Curtis et al., 2020). Additionally, when teachers perceived that they were already implementing some of the Teacher Discourse Moves in their classroom, teachers spoke of validation and a sense of confidence (McAneny, 2013). Middle school mathematics teachers in McAneny's study recounted how the pre-implementation phases of the PD on cultivating classroom discourse allowed them to have a new perspective on the importance of interactions in helping them attain the goals of the lesson.

While implementing new discussion-rich practices, teachers further described mixed emotions. One experienced teacher, Mr. Allen, described such emotional trajectories as feelings

of “chaos” and “anxiety” (Lloyd, 2008). A high school social studies teacher described shifting practice to dialogic pedagogy as “mentally exhausting” (Chee et al., 2015). These feelings, however negative in the moment, were replaced by positive teacher experiences. The high school social studies teacher in Chee et al.’s (2015) study ended up appreciating the change she experienced in her classroom as she transitioned from predictable, “tangible” PowerPoint slides and textbook activities to unpredictable, “intangible” student dialogue. She described her learning using the analogy of metamorphosis, going from “crawling” to “soaring”. One teacher in Vrikki et al.’s (2021) study talks about how he met an unexpectedly low amount of engagement from students while working in small groups on a unit on volcanoes. This realization led him to move from frustration to feeling like he developed a “good plan” as a result of implementing the lesson and observing students’ participation. Sedova (2017b) also describes the emotional trajectory that occurred as the focal (Czech language) teacher tries to maintain a curricular focus during book discussions with her class. After participating in video-stimulated discussions with the researcher, the teacher realizes that she did not need to be “nervous” or “afraid” of letting her students talk. In subsequent book discussions, the teacher facilitated discussions so that her students could talk with one another more frequently, thus allowing students to participate in more dialogic practices while simultaneously meeting the instructional goals. Thus, the video-stimulated discussions and support provided by the researcher allowed the teacher to move beyond her initial dissatisfaction with what appeared to her as inefficient discussions, and to essentially persevere as her practices shifted toward arguably more dialogic practices.

Participating in PD programs or professional training focusing on dialogue-intensive pedagogies subsequently contributed to shifts in teaching-and-learning beliefs and even teacher

identity. For English and geography teachers in Davies et al.'s (2017) study, focusing on students' capacity to communicate effectively with one another was challenging, particularly when, as a result of participating in a research intervention, teachers realized that they had been taking students' collective knowledge-building capacity for granted (see McAneny, 2013). Additionally, finding a balance between implicit instruction of productive dialogue moves versus tight classroom control was also challenging for many teachers. Chee et al. (2020) report how nine high school social studies teachers were trained to implement a digital learning game. Game training included guidance in how to enact a dialogic pedagogy. Their findings revealed that enacting the dialogic pedagogy was the most challenging component of the implementation cycles because of the way it challenged teachers' conceptualization of conventional classroom cultures. Teachers reflected on their learning, describing shifts in their understanding of the purpose of the textbook (e.g., not as a "Bible" but as a guide), their implementation of classroom interactions (i.e., supporting spontaneous dialogue), and their identity (e.g., from "control freak" to empowering student autonomy) (Chee et al., 2020). The teacher reported in Rumenapp (2016) as demonstrating non-dialogic teaching practices later reflected on videos that she recorded of her classroom interactions and came to realize that her over-directive discourse was creating a closed IRE style discourse in the classroom. For another EFL/bilingual teacher, this shift took the form of transforming her own assumptions of her students' identity, such that off-taskedness came to be associated with seeking "personal connections" opposed to relying on her initial biases (e.g., boys are more likely to be off-task).

Challenges to Adopting Research-Based Orientations on Dialogue

Teaching Expertise and Capacity to Implement Dialogue-Based Approaches. The relationship between expert and novice teachers played an important role in teachers' capacity to

understand, plan, and implement high cognitive demand tasks that engage student learning through purposeful discourse. When comparing the planning and implementation of discourse moves of two lower primary teachers in math, Georgius (2013) noted that the novice teacher often struggled to implement essential math questions, rarely referring to her notes and often diverging from the lesson plan. In contrast, the more advanced teacher, being more comfortable with the talk moves, was able to focus on bigger math questions and lesson goals, rather than being bogged down by the discursive strategies. Georgius' reflections on the teachers' work reveals that researchers may overestimate novice teachers' and their students' capacity to simultaneously handle multiple talk moves. This complexity caused frustration in the novice teacher, to the point that the teacher did not understand the benefit of insisting on a discursive method such as revoicing if the students struggled to participate in it.

Expertise also appears to affect whether and how teachers reflect on their practices in light of a more dialogic approach. Seymour and Lehrer's (2006) study speaks to the capacity of an expert teacher with 16 years of teaching experience. Highly educated with experience publishing articles and participating in research, this math teacher generated new "gambits" for math conversations that corresponded more closely to mathematical standards. These changes in her teaching emerged as a result of reflecting on her practice through individual reflective journal writing, video-stimulated interviews with the researcher, and then re-teaching the unit in light of observed contingencies (i.e., relationship between student learning and teaching assistance). These studies suggest that teachers' ability to identify and to respond to key learning moments in one's classroom discourse may be less transparent for more novice teachers. Findings also suggest a lack of knowledge on the relationship between dialogue and learning, which could

cause some teachers to reject dialogic practices in favor of more routine, controllable, and more emotionally positive experiences.

Dialogue Creates Genuine Problems of Practice. Research suggests that PD facilitators must not underestimate the potential of dialogue-intensive pedagogies to create genuine problems of practices for teachers' implementing dialogic approaches for curricular goals. Similar to Waymouth's (2020) observations of middle school science teachers, Oliveira (2010) found that elementary science teachers struggled with the idea of adopting a guiding position versus evaluating student responses. In fact, teachers in Waymouth's study actively resisted non-evaluative instructional practices, arguing instead that maintaining a non-evaluativist stance, presumably for the purpose of opening up discussion, may inadvertently promote the "read-my-mind" perspective that research on dialogue denounces. Two of the participating teachers (one first-grade teacher, and one fifth-grade teacher) opt instead for a neutral reaction, or even a nonverbal reaction, that provides a sense of direction nonetheless (e.g., "keep going", "try to look at that in a different way"). The first-grade teacher suggests that such practices may be appropriate during exploratory instructional phases; however, she emphasizes that neutral evaluations should be used sparingly during later instructional phases to avoid confusion.

Middle school math teachers in McAneny's (2013) study also realized that the assumed-to-be best practices for classroom interactions were not always beneficial for encouraging the student-centred perspectives purported in the literature when they were not dosed correctly. Teachers reported using "revoicing" much more than their students and how, in some instances, the teacher's revoicing was inadvertently diverting students' attention away from their peers' responses. A similar concern was voiced by two early elementary teachers teaching English Language Learners (ELL) who found the dialogic cues may support students initially (e.g.,

sentence starters, anchor charts); however, teachers feared that these resources may cause ELL students to fixate on specific statements and essentially overuse them (Meyer, 2016). In the end, teachers' awareness of these "moves" allowed them to focus on language (e.g., overuse of vague terms) as well as the moment-by-moment impact of interactions in working toward (or hindering) the overall goal of the lesson (McAneny, 2013). Aşık and Kuru Gönen's (2016) study suggests that even in their early stages of training (i.e., preservice teachers), teachers can recognize both the opportunities and the hindrances of overusing certain discursive cues, particularly when evaluating their own classroom discourse.

Mixed Benefits to Student Learning. In some case when teachers changed their practices to more dialogic approaches as a result of a professional development program, students' classroom discourse benefitted (Flitton & Warwick, 2013). Sedova et al.'s (2016) showed how, as teachers introduced more open discussions and intentional questioning practices (i.e., questions of high cognitive demand and teacher uptake), students' reasoning and argumentation discourse increased (Sedova et al., 2016). Teachers self-reported improvements in the quality and duration of their classroom science discussions as well as their own ability to sustain it (Hackling et al., 2011). Again, Osborne et al. (2019) observed a positive increase in students' scientific argumentation discourse ratings in teacher cohorts participating in a summer institute (professional development) instructing teachers on how to implement scientific argumentation practices.

While student achievement was observed in some studies (Anderson et al., 2018), this was not always the case (Osborne et al., 2019). In fact, in some cases, discussion-based practice negatively impacted student performance. Cheng et al. (2015) found that Collaborative Reasoning (CR) practices positively benefitted students' high-level reading comprehension (i.e.,

ability to integrate and evaluate information from a story). However, CR practices appeared to impede students' basic comprehension as seen in their surprisingly low scores (when compared to a control group) on information retrieval and simple inference multiple-choice test items.

Cautioning Against a Superficial Adoption of a Vocabulary of Change. Research on dialogue-intensive pedagogies also suggests that teacher learning can be aided by adopting a common language associated with dialogical principles and practices. For example, on one hand, researchers may provide teachers with an academic language or common vocabulary conjectured to aid teachers to collectively and/or individually analyze their practice and to attend to issues of student learning (McAneny, 2013; Scherrer & Stein, 2013; Sezen, 2011). On the other hand, teacher learning can be hindered by a superficial adoption of the academic language. Melville (2008) warns that while teachers may readily adopt language—in Melville's study, science curriculum reform language—this adoption does not necessarily mean that there is a deeper understanding of the language or implementation of it. In a narrative inquiry with 10 science teachers in a secondary school in Australia, Melville (2008) found that teachers perceived a complete disconnect between the science curriculum reformers and science teachers. While one teacher was able to negotiate meaning between reform language and her own practice, the broader language of the curriculum reform document appeared to be at odds with the precise, subject-specific language that teachers were accustomed to. Melville also noted that reform language and implementation was largely left up to the individual teacher, leaving room to misinterpretation, misunderstanding, and superficial application of its principles.

Teaching by the Book. In a similar vein, research reveals the difficulties that some teachers may experience when attending to general dialogic principles and approaches and often turn to book knowledge for support. In Waymouth (2020), a really interesting episode between

teachers is described when Marie and Elizabeth discuss two different methods for creating a summary content table. While Marie advises that the teacher creates the summary table in advance for students to see how their activities contribute to the storyline, Elizabeth repeatedly emphasizes the book's suggestion that students, not the teacher, create the summary table. When practices diverge from the "book" knowledge, possible explanations addressed include teacher expertise (e.g., Marie was a senior teacher with a doctorate and 26 years of experience) (Waymouth, 2020). The subject-specific context was also raised (van de Pol et al., 2017). Van de Pol et al. (2017), for example, discovered two distinct conceptualizations of dialogic teaching: Mitchell (the math teacher) described the core category of dialogic teaching in terms of democracy (information is available to everyone, everyone has the right to choose whichever problem-solving method they want based on their knowledge of the many methods available to find the correct solution), while Alice (the history teacher) described dialogic teaching in terms of being a co-learner with students. These findings suggest that some teachers conceptualize learning as the direct and transparent transfer of knowledge from books to practice.

Strictly adhering to book knowledge may create problematic situations for professional development and teacher learning, specifically when teachers expect (or demand) easily applicable resources. Even after providing extensive resources and coaching from the researcher, early elementary literacy teachers in Traga Philippakos et al.'s (2019) study viewed research-based resources as incomplete and requested more books, videos, and detailed examples of the targeted dialogic practices. This is not always the case. Larrain et al. (2017) observed how one Grade 4 science teacher flexibly used research-based materials, omitting some activities while adapting others from group-work to whole-class discussions.

Research has also shown how expectations for transparent application, coupled with ambiguous curricular mandates, can also lead to less-than-ideal uptake of pedagogical resources. In Georgius' (2013) study, the researcher in collaboration with two lower primary teachers revised a portion of the mandated math resources so that the math tasks and the discourse around them would more closely correspond to teaching practices for high cognitive demand tasks. While the school district required that teachers implement the math resources provided to the letter, the researcher noted that the curriculum did not always provide the mathematical knowledge necessary for informed practice, leaving the rationale for their use open to uninformed decision-making. While the researcher aided the teachers in developing informed alterations to the resources, a parallel could nonetheless be extrapolated between the mandated rules and the more novice teacher's implementation methods. For instance, the novice teacher insisted that her students conform to prescribed procedures on how best to solve a math problem. Her divergence from the revised curriculum meant that she spent less time focusing on students' understanding of the math concepts than on students' faithful adherence to the book method.

Time Constraints. Time also appeared to be a recurrent theme across studies on dialogue-intensive practices. Teachers expressed a need for more time to sufficiently train to use dialogic and inquiry-focused approaches (Lam, 2021; Waymouth, 2020). Managing the time necessary to implement dialogic practices was a challenge for teachers at the macro-level (e.g., school climate; political structures; pupil, parent, and educational system demands) (Wallen & Tormey, 2019) and the meso-level (e.g., curricular pressures) (Polojac-Chenoweth, 2020; Wallen & Tormey, 2019). At the micro-level, as well, teachers may find that they need to use time efficient strategies in an effort to keep discussions on topic (Sezen, 2011). In McAneny's (2013) study, teachers found that proposing open-ended discourse activities, while useful, were not

always feasible within limited time constraints (e.g., “Because there were times when they really, I thought, just time-wise, they needed to move on to other things”, p. 39). Some teachers talked about using some of the proposed PD activities during certain phases of their lessons rather than using all of the proposed activities. Other teachers had high expectations for change that, they felt, were not attained over the course of the year. For example, one teacher recounts how her students, by the end of the year, were still very dependent on teacher-led instruction.

Examining Cultures of Professional Learning

It becomes evident that the principles of dialogicality provide a potentially beneficial framework not just for classroom practice, but also for dialogic professional development cultures. Perry et al. (2020) conclude that “*whether* the intervention works is a less valuable question than asking what conditions it works under” (p. 633). Consequently, they and others (Chee et al., 2015) emphasize the professional learning culture, quality of facilitation practices, and the time provided to teachers to engage with the intervention as all important factors when assessing the success of dialogic interventions.

Another consideration includes whether research initiatives align with school districts’ pedagogical mandates. Osborne et al.’s (2019) study suggests that one of the original cohorts’ district-wide initiatives on “academic discussions” contributed to teachers’ positive involvement in the research-based PD and teachers’ improvement in facilitation practices. Later, when the PD initiative was “revised and improved” and proposed to new cohorts, no significant added improvements emerged. Osborne et al. signal the new cohort’s minimal involvement in the PD, most likely influenced by less district support than in the first cohort.

Additionally, the way that expert coaches also facilitate cultures of professional learning appear to benefit critical teacher learning. Haneda et al. (2017) found that dialogue as inquiry

allowed an expert Kindergarten teacher to challenge her understanding of student learning, allowing the teacher to break away from routinized practice enough to let herself be surprised by her students' capacity to understand the ramifications of environmental crises (e.g., oil spills). Haddy's (2008) study showed that the scaffolding in the form of dialogic coaching provided the expert support needed for one early career first-grade teacher to gain confidence and independence in her literacy beliefs and practices. Haddy associates this change with the development of a dialogic professional identity that empowered the novice teacher through guided reflection, permitting connections between theory and practice.

The time it takes before research can observe any kind of teacher change is also in tension. Many of the studies took place over the course of one academic year or even multiple years (see Anderson et al., 2018). This may simply not be economically or logistically feasible for some school districts. Scherrer and Stein (2013) found that teachers' ability to notice teacher–student interactions were improved after only eight hours of training; however, training did not manage to help teachers' capacity to identify how students' opportunities to learn are influenced by their pedagogical discourse. Given the relative lengthy amount of time that researchers spent studying teacher learning, the literature seems to agree with Howe and Mercer (2017) that providing the resources necessary for promoting sustainable dialogic practices can be a significant roadblock for educational administrators and other stakeholders searching for cost effective methods.

Discussion of Literature Review Results

In examining the literature on teacher learning within the specific context of dialogic pedagogy, there is a surprising scarcity of research on teachers' pre-existing knowledge, perspectives, and beliefs with regard to dialogic pedagogy, and how these change as a result of

participating in enactment and reflection cycles. Pre-/postintervention interviews aided in informing these points; oftentimes, however, teachers' classroom practices were the focus of studies, meaning that teachers' knowledge and beliefs had to be inferred. What's more, the literature provides some indications as to misalignments between teacher knowledge and practice. Yet again, we know very little about why misalignments may exist or persist. Better understanding teachers' conceptualizations and experiences with which teachers make sense of new pedagogical orientations is essential to understanding how teachers learn in research activities exploring dialogue-intensive pedagogies.

Furthermore, it is evident that the finer-grained relationship between teachers' knowledge, beliefs, and practices during changes toward more dialogic pedagogy remains a mystery. Wilkinson et al. (2017) found it puzzling that significant change in practice was not necessarily associated with a significant change in teachers' epistemological beliefs. Van de Pol et al. (2017) suggest that focusing on dialogic principles, opposed to techniques, caused a change in teachers' attitudes: "specific focus on the [Dialogic Teaching] principles, rather than solely on techniques, prompted attitudinal changes in the teachers that became visible in their pedagogical approaches" (p. 512). Their conclusions, along with others reviewed here, suggest an intimate connection between dialogic philosophy and teachers' tacit knowledge, beliefs, and attitudes. Future studies should continue exploring teachers' tacit knowledge and beliefs to better understand how this relationship manifests and affects pedagogical change.

In contrast to the paucity of information about teachers' experiences and tacit knowledge, we know quite a lot about the practical side of proposing different programs to promote various dialogic practices. In fact, a quick search online reveals the enormity of resources targeting educators. Despite the volume of practical guides, tips and tricks, and resources, without

understanding the deeper learning factors that affect their up-take, it is likely that we will see teachers implement dialogic strategies without understanding why the uptake is, at times, less long-standing than expected. Like Lee and Tan (2020), I agree that research needs to refine and operationalise teacher learning domains in light of existing models of teacher learning.

Conclusion of Literature Review

Methodologically, the literature review findings present opportunities and challenges for future qualitative research. As stated by Hofmann (2020), "visible appropriation of dialogic classroom norms emphasizing the importance of talk is not a sufficient condition for change" (p. 215). Inherent in Hofmann's statement is the argument that more is going on in the classroom than what researchers are able to observe from short-term or sporadic video recordings. As evidenced in the studies reviewed here, it was only when teachers engaged in reflective interviews and discussions with the researcher, other teachers, and educational professionals that important nuances to teachers' tacit knowledge emerged. Consequently, finding a balance between prescriptive practices in research and open explorations about what productive dialogue looks like for teachers is a challenge facing research. As described by Postholm (2015), Leont'ev (1978) contended that people perceive the object differently based on their own subjectivity; the main idea is about developing personal sense of the object. These tacit factors are simply not as easily accessible when using large scale surveys (see Perry et al., 2020).

STEM disciplines, particularly mathematics, also appear to be a particular subject-specific context in which dialogic practices may face their own complexities as opposed to disciplines in which relying on different perspectives may not be as problematic to curricular goals. For example, the relationship between precision and conceptual understanding remains a concern of researchers and educators working with students in small-group activities in

mathematics (Chiu, 2008; Sengupta-Irving & Agarwal, 2017). In exploring dialogic pedagogical practices incorporating peer-led small-group activities, individual indicators associated with positive student learning include students monitoring and refining their own and their group members' contributions (Goos et al., 2002). Associated with self-regulation, these metacognitive processes manifest themselves in instances when students check (or monitor) their progress or comprehension of a task in relation to their own or another's knowledge of the task's goals and the strategies needed to accomplish the goal (Butler & Winne, 1995). Students' correct contributions during small-group problem-solving are an important component of successful problem-solving processes, and their occurrence appears to be dependent upon high quality justifications and students' mathematics grades (Chiu, 2008). In the end, using dialogue-intensive pedagogies in mathematics reveal some specific hurdles of its own, particularly the development of metacognitive skills necessary for success in mathematics which may seem to be in contradiction with the open nature of dialogic practices, even though academics strongly contend the contrary (Colonis, 2011; Williams & Ryan, 2020).

Finally, research posits that school-based programs (e.g., communities of learning) appear to offer the longevity and support that teachers need to learn (Postholm, 2012). Hardman (2020) implies that this learning happens when teachers can work through and try out ideas with their colleagues and get feedback from peers and expert practitioners. Yet, the articles reviewed here challenge our understanding of what types of benefit (cognitive, social, affective, motivational) these collaborative activities have on teacher learning. With the knowledge we have today, it would be premature to insist that these collaborative inconsistencies uniquely arise when learning dialogic pedagogy. Indeed, Postholm's (2012) review suggests that some of these

tensions arise when teachers learn any new knowledge or pedagogical practices in collaborative settings.

Arguably, investigating dialogic pedagogy is a fruitful basis upon which research can better understand the challenges that teachers' face when confronting philosophical perspectives underpinning dialogue-intensive practices and approaches. Research reveals how participating in research allowed some teachers to address these philosophical perspectives for the first time in their careers. For others it is possible that constructivist, sociocultural, or other dialogue-focused perspectives were addressed early in their teacher training, but which have simply been forgotten, diluted, or rejected altogether throughout the course of teachers' experiences. Without this valuable knowledge, research on processes of adopting dialogic approaches, and on teacher learning more broadly, will remain a mystery.

Chapter 3: Methodology

Research Questions

This study investigates teachers' learning processes. Specifically, the aim of this study is to explore whether and how participating elementary and secondary mathematics teachers adopt dialogic approaches to teaching and learning while participating in professional development on dialogic pedagogy involving collaborative online workshops and iterative classroom experimentation. To answer this broad research inquiry, three research questions are addressed:

1. How do participating teachers experience and conceptualize dialogue for learning in the mathematics classroom before participating in professional development on dialogic pedagogy?
2. What do teachers' workshop discourse reveal about the tacit knowledge and beliefs that influence math teachers' decision-making when planning for, implementing, and assessing dialogue for learning in their classroom?
3. What evidence is there that teachers changed their practices, perspectives, knowledge, or beliefs on dialogue for learning after participating in workshops and classroom experimentation on dialogic pedagogy?

Research Design

Connecting with Philosophical Assumptions

This study is situated in a larger multimethod qualitative research project investigating teacher and student dialogue and learning. To specifically investigate teacher learning, this study draws on multiple sources of data, primarily in the form of pedagogical discourse, collected during teachers' collaborative online professional workshops, individual pre–post workshop interviews and verbal instructions/feedback provided to students during math lessons. The

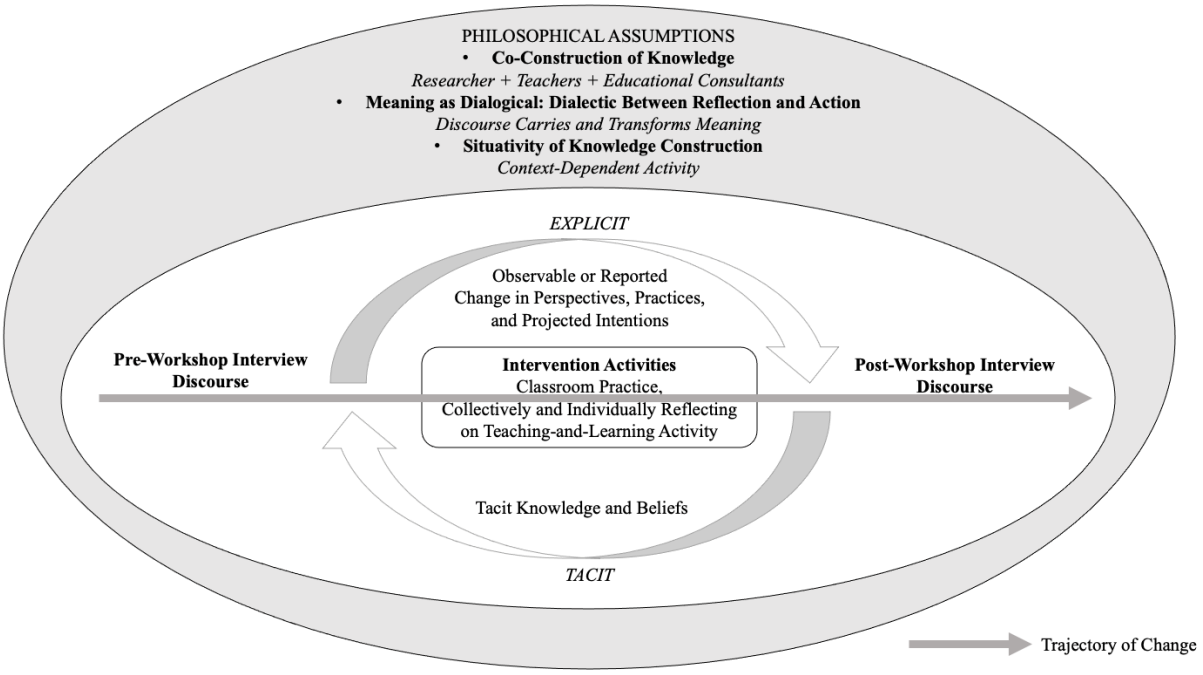
multimethod research approach (Mik-Meyer, 2020) underpinning the design of this project demands that careful attention be paid to the alignment between the multiple forms of data used to investigate the phenomenon under study and their sometimes-diverging philosophical assumptions. The next paragraphs situate each of the data collection methods within the overall philosophical framework guiding my exploration and investigation of teacher learning.

The research design was built on the philosophical assumptions that teacher knowledge and beliefs are co-constructed (Guba & Lincoln, 1994). Teacher learning (and adult learning more broadly) is conceptualized as the process of making personal sense out of collective activity, particularly activity based in teachers' authentic professional practice. Within these meaning making processes, the influence of psychological (i.e., epistemic) factors (Cook & Brown, 1999) are ascertained through participants' discourse and interpreted iteratively and reflexively as they relate to participants' trajectories of reflective, purpose-driven activity (Engeström & Sannino, 2010). In this sense, meaning is dialogical, simultaneously emerging from and influencing culturally and historically valued (Miller, 2014; Vygotsky, 1934/1987) professional discourse and pedagogical activity.

It is further assumed that meaning is situated (Brown et al., 1989; Enyedy et al., 2006). Multiple contexts, as opposed to one single context of teacher discourse, are also assumed to better convey teachers' tacit knowledge, beliefs, and motivations (Engeström, 1999), the rationale being that teachers' own assumptions are put to the test, particularly when contextualized within authentic practice, such as teachers' classrooms (Schön, 1983), or when confronted with surprising, conflicting, or challenging episodes of student learning (Cobb et al., 1990; Johnson & Owen, 1986). A model sketching out how the research design connects to the philosophical assumptions can be found in Figure 1.

Figure 1

Model Connecting the Research Design to the Philosophical Assumptions



The Intervention: Collaborative Workshops and Classroom Experimentation

In line with these assumptions, a professional development (PD) intervention was undertaken, providing teachers with tools and resources: (a) to conceptualize dialogue for learning, and (b) to collaboratively explore strategies for promoting more dialogic forms of talk in the mathematics classroom with the ultimate goal of improving student learning. The PD intervention was entitled *Scaffolding Students' Metacognitive Engagement with Dialogue* (Titre français : *Comment aider les élèves à s'engager de façon métacognitive au sein du dialogue*).

The intervention consisted of workshops that gave teachers the opportunity to share and reflect on their perspectives and experiences planning for, implementing, and, eventually, transforming their classroom interactions toward more dialogic forms of talk. With these goals in

mind, each PD meeting was designed so that teachers could share any challenges or opportunities that they met/meet while planning for, implementing, or thinking about implementing norms for classroom dialogue, a dialogue-intensive mathematics activity, or productive mathematics discussions in their classes. Research-informed case studies focusing on authentic instances of student "math talk" (Cooke & Adams, 1998; Hufferd-Ackles et al., 2004) also provided genuine problems of practice, conceptual and practical, that teachers might face while implementing discussion-rich activities in the mathematics classroom. A typical workshop followed the structure outlined in Table 1 below. Specific examples of activities are given in the next sub-section.

The PD intervention also provided teachers opportunities to collectively reflect on their practices, experiences, and any changes with fellow practicing teachers in a collaborative manner. Collaboration (Desgagné, 1997) entails engaging teachers in professional conversations

Table 1

Typical Workshop Structure

Sequencing	Activity	Projected duration
Introduction		20 minutes
	Open sharing of teachers' thoughts, practices, perspectives, etc.	
	Presentation/Identification of a problem of practice	
Research-based perspectives		15 minutes
	Key concepts and directions for practice (what have we learned from research?)	
	Points that research is still exploring (what do we still need to investigate?)	
Group activity		30 minutes
	Interactive group activity (may begin or end with individual reflection)	
	Critical reflection as a group, examples from teachers' classrooms.	
Final discussions and concluding remarks		20 minutes
	Reconciling practice with research	
	Resources for classroom practice (e.g., keeping a trace of students' dialogue)	

creates opportunities for educational professionals to collectively explore the opportunities and communities of educators, sustainable practices are more likely to emerge. It was also conjectured that an approach inspired by design-based research (DBR) (Bakker, 2018; Barab & Squire, 2004) would allow the researcher and educational staff (i.e., teachers, educational consultants) to mutually benefit from the research project. A DBR-inspired methodology ensured that the research project continuously attended to different stake holder perspectives through iterative cycles of knowledge refinement. This process includes remaining in tuned to the student learning challenges lived by participating teachers. This included collecting multiple samples (i.e., at least three recordings) of classroom practices, including teachers' experimentation with dialogue-intensive approaches. These recordings would allow me to better understand the process of change by observing and analyzing concrete examples of participating teachers' and students' lived experiences in the classroom over multiple time points. This iterative process also served to enrich research knowledge of dialogic implementations, changes, and challenges. Furthermore, it was hoped that these implementations/experimentations would provide teachers with a concrete springboard upon which they could contribute to the critical and reflective professional conversations provoked throughout the workshops. Finally, it was assumed that this collaborative, DBR-inspired research design would contribute to the ecological validity of the research findings and results.

Validating Workshop Materials

Extensive preliminary research went into the materials prepared for the workshops. These results translated into the following workshop discussion themes: promoting a dialogic classroom climate, scaffolding quality dialogue, and principles for planning and facilitating high-

quality tasks for dialogic and metacognitive goals. Taken as a whole, these three themes formed a pedagogical framework built around the principles of dialogic pedagogy (see Appendix B).

Embedded in this dialogic pedagogical framework also lay the concept of metacognition. Metacognitive processes and their successful engagement in learning activities (i.e., self-regulation) has gained attention in recent research on dialogue (Whitebread et al., 2013). While this is not a new phenomenon in educational research more broadly (Bransford et al., 1999; Donovan & Bransford, 2005), research shows compelling evidence that teachers should be sufficiently informed of the "power" of verbal feedback (Hattie & Timperley, 2007; Perry et al., 2020)—whether teacher-led or student-led—in engaging or disengaging students' metacognitive engagement with curricular dialogues (Goos et al., 2002; Hattie, 2009; Higgins, 2013; Perry, 2013; Veenman & Spaans, 2005; Wang et al., 1990; Whitebread & Pino-Pasternak, 2010).

Workshop themes were supported by several research-based materials. To support teacher-led inquiry throughout the workshops, teachers were given access to materials from Cambridge University's T-SEDA teacher pack (2019/updated version 2021) (see Hennessy et al., 2021; T-SEDA Collective, 2019, 2021). This pack was chosen based upon its creation within sociocultural perspectives and coherence with the dialogic philosophical assumptions underpinning this research project. Additionally, materials and extensive examples were freely available online through the T-SEDA website, which was conjectured to give school boards freedom to explore the materials after the research study should they choose to go further in this direction. Some materials required translation from English to French, which I did myself as these materials had not yet been translated into French at the time of the study.

Other workshop activities and tasks were based on previous research activities with my supervisor and research lab. Multi-year work collaborating with educational leaders and

mathematics teachers in research-practice partnerships also informed my choices (Breuleux et al., 2018a; Corriveau et al., 2020). Additionally, and in coherence with a design-based research project, several discussion activities and tasks were created in response to emerging comments and interest expressed by teachers and consultants during our collaborative discussions before, during, and after workshops. Furthermore, workshop materials were extensively worked and re-worked to provide the most informative and reflection-provoking content possible, based on the most recent research literature on dialogue and learning. Systematic literature reviews were conducted to identify key issues in classroom dialogue and strategies to facilitate more productive dialogue. Extensive conversations with fellow academics in educational psychology, mathematics educators, and researchers in mathematics didactics further informed my choices.

Adaptations in Response to COVID-19

The COVID-19 pandemic caused unprecedented changes in educational contexts throughout the world. This research was not immune to these changes. The design-based research approach underpinning the original design of this study greatly aided in providing the flexibility needed to adapt to this unexpected crisis. Indeed, design-based research urges researchers to consider new situations and to be better attuned to participants' lived experiences (Bakker, 2018). These adaptations were nonetheless met with many challenges, including delays in the ethics review process due to the backlog arising from the multitude of research projects seeking approvals for modifications in response to the pandemic.

The most immediate change involved the format of workshops. Workshops were initially organized as in-person professional development. Workshops were migrated to an online format. With school closings, lack of teacher availability, and fluctuating student attendance, I also wanted to create more flexibility for teachers to attend the workshops. Thus, the original day-

long format was transformed into shorter 1.5-hour online workshops taking place three times, at approximately three-to-four-week intervals during the Winter 2021 trimester. The duration and frequency of these meetings were subject to the availability and interest shown by school boards as well as the limited resources available to the project.

It was also questioned whether classroom observations would be possible given the circumstances. School Board A (see below) confirmed that they would not be participating in the classroom observation components of the study. In contrast, School Board B supported the opportunity to provide classroom observations for the research project. The pedagogical consultants from School Board B agreed to the idea that teachers attempt to follow-up each workshop with their own classroom experimentation or, if teachers preferred, to simply continue business as usual. Pedagogical consultants from School B requested that these research-based classroom recordings be shared with the school board for in-house professional development purposes. Thus, despite the opportunities available through a multimethod collaborative research design, the ethics review process proved to be a long and complex process.

Critical discussions about the workshop content and activities were also tackled. Questions of alignment with theories of adult learning in online (opposed to in-person) professional development environments were evaluated. Workshop activities and materials were maintained since they aligned with principles of authentic e-learning (see Herrington & Oliver, 2000; Herrington et al., 2009; Teräs & Kartoğlu, 2017) while also reflecting the original philosophical assumptions of the research. As discussed earlier, the collaborative, design-based aspects of the study design permitted a certain amount of flexibility to make adaptations to the content if necessary to better adapt to the realities of online learning.

Recruitment Procedures

Eleven school boards within proximity of the university were contacted to participate in the study. The proximity was an important criterion to ensure the feasibility of travel should the health situation ameliorate.

School boards were contacted by phone or email with an overview of the project's overall goals, methods, benefits, and confidentiality statement for research participation. If interested, the school board communicated their procedures for conducting research in their school board. Each school board in Quebec has their own procedures for participating in research.

Of the eleven school boards contacted, two school boards agreed to participate in the study. Because of limited resources available, invitations to participate in the research project were extended only to teachers teaching mathematics around the transitional years between primary and secondary education (late primary school/early secondary school) (i.e., 4th/5th grade through 8th/9th grade). Pedagogical consultants were invited to participate if they wished.

It is worthy of note that the two school boards who agreed to participate were already involved in programs encouraging discussion-based approaches to learning in mathematics. **School Board A** had participated in a multiyear research-practice partnership with my supervisor in previous years exploring questions of collaborative learning, collaborative curriculum design, and technology-mediated learning in mathematics. Joining the team toward the end of the partnership, I had the opportunity of collaborating with some of the members of the school board (assistant director, consultants, teachers). I was acquainted with one of the teachers who agreed to participate in this study.

When communicating with the elementary mathematics pedagogical consultant from **School Board B** (Dec. 2020/Jan. 2021), I learned that her school board had previously

participated in an action research project with researchers from my university faculty. In our discussions, she wanted to ensure that we were on the same page when it comes to the socio-interactional aspects of classroom talk and the importance that these aspects have for classroom learning, especially, the place of talk in teachers' practices. In fact, she began the meeting by asking about my theoretical "angle" when talking about dialogue. She wanted to see if there could be any bridges between her understanding of classroom talk and my project, emphasizing the new mathematics reference manual by the Ministère de l'Éducation (2019) that states that "students must have room to discuss" (*l'élève doit avoir la place pour discuter*) (her words). What's more, she emphasized that, ideally, she would like the workshop materials and classroom recordings to be available to the school board so that they could continue the workshops even after the end of the project. She shared how teachers had a hard time identifying (linguistically, culturally) with the videos available on discussion-based approaches and how this project could give them an opportunity to see one another's classrooms.

In the first school board, School Board A, the first group of teachers were recruited through their school board and their school principal. In School Board B, the recruitment process took place through the school board and the mathematics pedagogical consultants. In School Board A, consent forms were communicated to teachers via email. In School Board B, pedagogical consultants served as liaison between the research and the teachers, communicating all consent forms and necessary documents by email or in paper form. Because of constraints and increased workload associated with the pandemic, School Board B was the only school board that agreed to coordinate classroom observations with teachers, parents, and students. Students and their parents in School Board B were recruited through their classroom teacher.

Written consent to participate in the project was received from participating teachers, pedagogical consultants, parents, and students. The project provided release time for participating teachers should the workshops take place during normal school hours. School B provided teachers release time to participate in the pre-/post-workshop interviews.

Participants

A total of 12 teachers—seven elementary teachers and five secondary mathematics teachers—from 11 different schools agreed to participate in the study (see Table 2). Additionally, two pedagogical consultants specializing in mathematics—one at the primary level, the other at the secondary level—also agreed to participate at School Board B. All participating adults were females. Students (n = 113), with consent from their parents, from seven of the participating teachers' classrooms in School Board B also agreed to participate (see Table 3).

Table 2

Overview of Participating Teachers

Name[a]	School board	Workshop group	Grade(s) taught	Teaching experience (years)
Sarah	A	1	4	10-15
Audrey	A	1	5/6	15-20
Vicky	A	1	5/6	15-20
Julie	B	2	5	25-30
Emilie	B	na[b]	5	0-5
Cindy	B	2	6	25-30
Mélissa	B	2	6	5-10
Valérie	B	3	7	15-16
Isabelle	B	na	8	5-10
Céline	B	3	8	15-20
Sylvie	B	3	7/8/9	20-25
Caroline	B	3	7/8/9	15-20

Note. [a] Pseudonyms are used. [b] Teachers who did not participate in the full project.

Table 3

Overview of Classrooms Participating in Recordings (School Board B)

Class	Grade	Total number of participating students	Geographical situation of the school	Socioeconomic index of the school[a]
Class A	5	16	suburban	2
Class B	6	18	suburban	4
Class C	6	17	suburban	4
Class D	7	3	suburban	6
Class E	7	20	suburban	7
Class F	7	24	suburban	1
Class G	8	15	rural	1

Note. [a] The index reflects the proportion of families whose revenue is near or below the low income cut-off, referred to as the SFR index in Quebec (see http://www.education.gouv.qc.ca/references/indicateurs-et-statistiques/indices-de-defavorisation/).

In School Board B, each participating teacher was invited to record one small group at three different time points over the course of the study. Group formation strategies were left to the discretion of the teacher. An overview of the students in the recorded small groups can be found in Table 4. For each student participating in the recorded small group, teachers were asked for students' age, sex, and general academic performance.

Table 4

Overview of Students in Recorded Small Groups

Class	Grade	Age	Sex	Academic performance
Class A	5	11-12	3 females / 1 male	1 high/2 average/1 low
Class B	6	11-12	3 males	1 high/1 average/1 low
Class C	6	12	1 female/ 2 males	3 high
Class D	7	12	1 female / 2 males	3 low
Class E	7	12-13	4 females	2 high/1 average/1 low
Class F	7	13	2 females / 2 males	1 high/2 low/1 very low
Class G	8	14-15	1 female/ 3 males	1 high/2 average/1 low

Instruments

Pre-Workshop Interview Protocol

A semi-structured interview protocol (Van der Maren, 1996) was constructed based upon the broader literature on classroom practices within the context of small-group activities and classroom dialogue more generally (see Appendix C). Specifically, interview questions were designed to elicit open responses about teachers' beliefs, practices, and perspectives regarding the role of dialogue in the classroom for student learning. Teachers' pedagogical knowledge (conceptual, organizational, curricular, and assessment knowledge) was also elicited.

Some questions prompted closed responses in the form of simple or Likert style questions (i.e., on a scale from 1 to 5, do you/how often do you…). However, the prompts were created in such a way that teachers could expand their answers, divert from the "1 to 5" format or go in another direction altogether if they chose. In this way, even closed questions (i.e., Likert) allowed for open responses. Overall, approximately half of the interview questions (47%) elicited perspectives on teachers' beliefs, perspectives, and experiences in the classroom; a little less than half (42%) of the questions elicited descriptions of teachers' classroom discussion routines within small group and whole class contexts. The remainder of the questions (11%) targeted general demographic information.

Additionally, the interview protocol was designed such that the questions would follow the natural flow of conversation as much as possible. Therefore, there was not a strict order in which questions were asked.

Post-Workshop Interview Protocol

As with the pre-workshop interview, the post-workshop interview also followed a semi-structured protocol (see Appendix D). The post-workshop interview served as a moment to

discuss teachers' impressions and experiences participating in the workshops and classroom experimentation, and to elicit responses related to any changes or learning that teachers perceived, whether in their own learning or their students' learning. Several questions posed in the first interview were asked again in the second interview to trace any changes in responses and to reduce social desirability bias.

Instrument Validation

Advanced graduate courses on qualitative methods and extensive reading of the literature on pedagogy, curriculum, and praxis informed the choice of questions used in the interview protocols. Additionally, my own experiences as a teacher as well as experiences conducting research with mathematics teachers, educational consultants, and curriculum specialists informed my choices.

Initial interviews served as a pilot to assess how teachers interpret and respond to the questions. For example, when I began asking teachers "How do you assess whether a small-group activity is successful?" I immediately noticed that teachers changed their demeanor and were hesitant to respond. With such questions, teachers may understandably interpret this question as a form of evaluation; thus, I began to follow-up this question with a reminder that there are no right or wrong answers. I observed an immediate change in teachers' demeanor (i.e., teachers adopted a more relaxed demeanor and openly shared their perspectives and practices).

Additionally, specific measures were taken to reduce social desirability bias (McMillan, 2016). The need to address social desirability bias was particularly relevant in instances where researchers ask teachers about their learning (e.g., "Did you learn anything new?"). Teachers may feel the social pressure or professional obligation to have learned something during the study or workshops. In these cases, I regularly reassured teachers that it was okay if they found

certain material to be difficult to understand or in need of adjustment. I positioned myself as a researcher-learner, exploring the best ways to help teachers and students learn. Additionally, during analyses, I remained critical in response to teachers' self-reported learning. For example, a teacher stating "Yes, I learned a lot." would prompt further questions into the 'what' and 'how' behind the learning.

Instrument validation also occurred through iterative cycles of reflexivity. Reflexive memo writing at each stage of the process aided me in keeping track of all changes suggested or made in response to teacher and pedagogical consultant comments and evidence of learning. Evidence of teacher learning (e.g., how teachers' perspectives, practices, or beliefs change as the workshops progress) was indeed integral to the way each workshop was reviewed for possible adaptations or additions.

Procedures

In School Board A, the activities validated by the school board's research review board included the online workshops, the pre-/post-workshop interviews, and email responses to project-related activities. In addition to interviews, workshops and email responses, teachers in School Board B were also invited to record three math lessons that they planned in their classroom, and which involved a collaborative math task. The decision to have these recordings take place after each respective workshop was jointly decided on by the participating educational consultants (School Board B) and myself so that teachers could implement ideas that they learned during the workshop or to simply provide evidence of classroom teaching and learning as the study progressed. Additionally, one of the negotiated aims of the project was also to provide tools and resources for pedagogical consultants (School Board B) to continue reflecting on opportunities for scalable professional development more broadly within their school board.

Consequently, conversations with participating pedagogical consultants led to a novel protocol that would allow their school board to retain the classroom recordings of learning activities implemented in the participating teachers' mathematics classrooms. By allowing school boards to have access to classroom recordings from their own schools, the goal was to equip and empower teachers and consultants to continue exploring ways to reflect on and improve dialogic interactions in their classrooms.

Teachers from School Board A communicated that their schools were having a hard time finding replacement teachers to cover their shifts should they attend the workshops during school hours. Therefore, we jointly decided on a common time when we could all meet online right after school. In contrast, pedagogical consultants in School Board B proposed dates/times during school hours and scheduled the workshops once availabilities were confirmed.

All the interventions took place online. This meant that interviews, workshops, and other exchanges with educational consultants and teachers took place using Microsoft Teams (e.g., conferencing call, chat) or email. Pedagogical consultants occasionally assisted the participating teachers in their classrooms. Consultants, teachers, and students followed provincial health regulations in effect during the duration of the study.

Teachers were invited to participate in the first interview (**Interview 1**) on Microsoft Teams prior to the first workshop. Interviews were scheduled to last 45 minutes to one hour. Teachers were given the choice to turn off their camera if they preferred, although all of the teachers opted to leave their cameras on. Teachers were advised that there were no right or wrong answers since one of the study's main purposes was to better understand teachers' perspectives, practices, and lived experiences, rather than comparing teachers' knowledge to a set of criteria.

Teachers were then invited to participate in three workshops (**W1, W2, W3**) on Microsoft Teams. Teachers were divided into three separate groups: primary teachers from School Board A (**Group 1**), primary teachers and primary math consultant from School Board B (**Group 2**), and secondary teachers and secondary math consultant from School Board B (**Group 3**). It was posited that smaller, cycle-specific (i.e., primary vs. secondary) groups would encourage more participation and more specific curricular conversations. School board, school, and teacher constraints, resource availability, and logistic feasibility also played an important role in grouping decisions. Each workshop group had their own Microsoft Teams group in which teachers could access shared documents and resources.

In School Board B, the pedagogical consultants offered to meet with me before and after each workshop to discuss the presentation materials before meeting with the teachers and then to have a debrief about our own general reactions and reflections for future workshops. Pre-workshop meetings with both primary and secondary pedagogical consultants from School Board B lasted approximately 90 minutes to 120 minutes and took place one week before each workshop.

Workshops lasted 90 minutes. Workshop generally began with introductions, teacher-led classroom updates, teachers' classroom observations, questions, or comments. Following introductory discussions, teachers were introduced to targeted research-based perspectives based upon the topic of the workshop. Reflective discussion questions were integrated into the presentation to provide teachers with the space to share their thoughts on the topic and to describe their lived experience in the classroom. A group activity was also proposed, centring around reflective discussion questions, an interactive online discussion board or a specific research-based resource. In the case of research-based resources, teachers were introduced to the

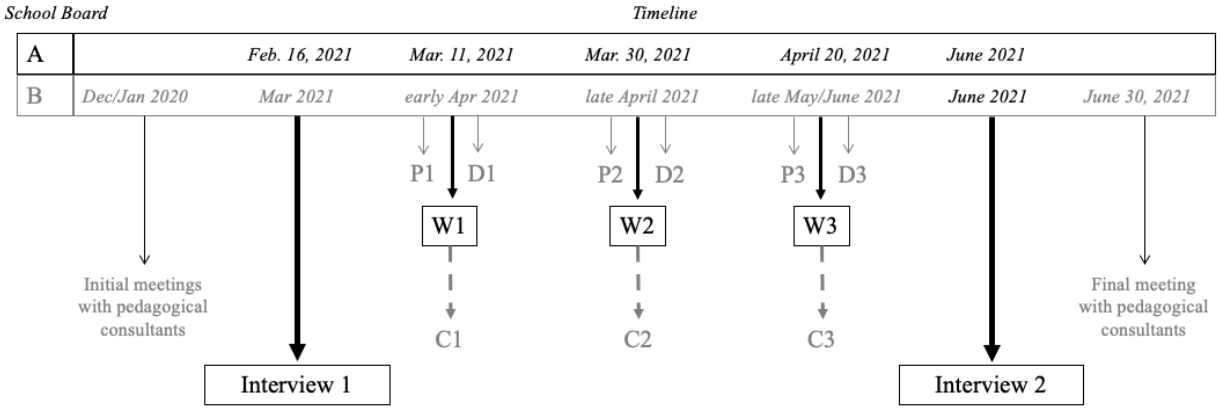
resource with discussions around the value of the resource for their own practice. Importantly, teachers were positioned as experts. As the researcher facilitating the workshops, I maintained a distant criticality in relation to the resources to reduce the chance that teachers feel required to adopt the resource. I aimed to encourage critical reflections about the resource and the resource's purpose for teaching and learning goals, rather than blind adoption. Debrief discussions with the grade-specific consultant attending the workshop took place immediately after the workshops and lasted approximately 15 to 30 minutes.

In School Board B, participating teachers audio and/or video recorded three collaborative math lessons with their students using a secure personal recording device (e.g., Smartphone, laptop). Teachers aimed to record one collaborative math lesson after each workshop. To do so, teachers followed a strict protocol designed for this study that was distributed to them along with the consent forms in a paper-based research packet delivered to them via their pedagogical consultant. The packet gave specific instructions on how to securely record and upload recordings to the study's online university-based server via Microsoft Teams, in accordance with the research ethics board requirements. Teachers also uploaded examples of participating student work to the same site.

At the end of the study, teachers were invited to a final, post-workshop debrief interview (**Interview 2**). Interviews were scheduled to last approximately 45 minutes. Teachers were advised that some questions would be the same or similar to ones asked during the first interview but that, again, there were no right or wrong answers. A final debrief meeting (1 hr 15 min) took place with both primary and secondary consultants from School Board B. The study design components and timeline can be found in Figure 2.

Figure 2

Study Design Components and Timeline



Note. Light grey text (e.g., C1, C2, C3) indicates research activities unique to School Board B. P =preworkshop meeting with pedagogical consultant, D=debrief meeting with pedagogical consultant, W=workshop, C=classroom recording.

Data Collection

Multiple forms of discourse constituted the data for this study (see Appendix E). All discourse data were transcribed verbatim from audio/video recordings. Transcriptions followed a simplified Jeffersonian notation (Jefferson, 1984) (see Appendix F). While transcribed speech formed the corpora for the analytical procedures (described in more detail below), participants' original audio/video recorded responses remained the primary reference. Observational notes and memos were also essential pieces of data throughout the different analytical procedures.

Data Analysis

A Constructivist Grounded Theory Approach

A constructivist grounded theory approach (Charmaz, 2006; Strauss & Corbin, 1990) was utilized to inductively analyze the discursive data. This approach utilizes the constant

comparative method through open, axial, and selective coding as data is compared with codes, codes with codes, and codes with categories (Glaser & Strauss, 1967).

In grounded theory, researchers collect more data as their study progresses through theoretical sampling (Strauss, 1987), with the goal of refining their emerging categories (Charmaz, 2006). In this study, theoretical sampling procedures were built into the design of the research project (i.e., inquiry questions, collaborative discussions, classroom observations, and follow-up reflection). Within a logic of collaboration, this decision also provided the necessary flexibility so that the workshop activities might better respond to teachers' emerging experiences and questions. Observational notes and memos (category-generating and reflexive) were made throughout these processes and informed subsequent workshop directions. In this way, data analysis began simultaneously with data collection (Charmaz, 2006).

More traditional line-by-line analysis and theoretical sampling procedures took place once all data were collected and transcribed. Transcribed data were imported into the qualitative data software MAXQDA (20.4.2) for analysis. To answer each research question, I followed a four-phase approach informed by Creswell's (2007) interpretation of Strauss and Corbin (1990):

- *Phase 1: Open coding*. Phase 1 entailed line-by-line analysis, *in vivo* coding, and memo writing. Potential categories and emerging sub-categories were identified. Contradictory or noteworthy cases were also identified to stay grounded in the data.
- *Phase 2: Axial coding*. This stage involved organizing categories in relation to causal conditions, or *factors* (e.g., explanations given for one's actions; the why, when and where) that surround the "core" phenomenon (e.g., dialogue and the processes helping/hindering its emergence in the math classroom), the *strategies/routines* to promote the core phenomenon (e.g., strategies for promoting productive dialogue in the

math classroom; the what and how), *intervening conditions* (e.g., internal/external conditions that influence the choice and uptake of the strategies chosen), and *outcomes* (e.g., how and whether dialogue emerges, as well as the different forms dialogue may take).

- *Phase 3: Selective coding and preliminary model building*. During this phase, the properties and dimensions of categories emerging from sub-categories as well as the credibility of the hypothesized relationships between categories were tested in relation to the data, and an emerging model was constructed (e.g., a model of teachers' tacit knowledge and emergent dialogic practices). Reflective notes taken immediately following meetings with the pedagogical consultants served as a preliminary form of member checking. These meetings were essential sources of data to inform the potential categories or properties of categories emerging outside of the interview/workshop discussion and that may be significant indicators of teachers' tacit knowledge and overall learning processes, as well as to remain in-tuned to any possible challenges affecting teachers' understanding or uptake of pedagogical concepts or materials presented during the workshops.
- *Phase 4: Theoretical saturation.* The final phase entails putting the resulting model to the test in relation to other sources of data. These processes entailed exploring more deeply additional sources of data (e.g., subsequent workshop discourse, ethnographic classroom observations) and, in some cases, investigating specific cases retrospectively (e.g., based on post-workshop interview response) for added depth to interpretations. Referring to an interview that she conducted with sociologist Jane Hood, Charmaz (2006) compares theoretical sampling to "tightening a corkscrew" as attention is directed to only those

categories and concepts most closely adhering to the data (p. 101). Peer debriefing also played a key role at this phase to increase credibility of interpretations. These processes give way to a micro, or "lite" theory (Braun & Clarke, 2013) of teacher learning of dialogue-intensive pedagogies, as further sampling continue to point to the established categories and the relationships between them.

In coherence with a constructivist approach, emerging findings to each research question iteratively informed the other research questions. This meant that each research question was treated both successively (i.e., findings in response to RQ1 informed analyses of RQ2, etc.) and retrospectively (i.e., findings to RQ2 provoked reflection on the manner in which findings to RQ1 were interpreted). In this sense, there was no intention to definitively segment findings around research questions. The boundaries of questions serve pragmatic purposes, acknowledging the need for boundaries for the benefit of readability. But, again, the emerging findings never fully begin or end in a clear-cut way with each research question. Procedural considerations associated with each research question are thus elaborated below.

Research Question 1: Exploring Teachers' Experience and Conceptualizations of Dialogue for Learning.

Corpora:	Recordings and transcripts of Interview 1 (i.e., preworkshop interviews), observational notes and memos, member checking notes with pedagogical consultants
	Coded segments represent 71% of the Interview 1 data set. The remaining 29% not coded included exchanges that were unrelated to study (e.g., small talk) and linguistic fillers (e.g., yeah, um).

Unit of Analysis:	The meaningful unit (Linell, 1998) (as it relates to its pertinence to the research question) although mostly took the form of teacher turns during individual interviews.

Phase 1: Open coding. All 12 interview responses were read and analyzed holistically to generate an overview of teacher characteristics. Afterward, only 10 out of 12 interview responses were analyzed line-by-line. The line-by-line coding concerned the 10 teachers who participated in focal features of the study (i.e., pre-/postworkshop interviews, workshops, classroom implementation).

Phase 2a: Axial coding (early stages). As stated earlier, the core phenomenon at early stages of data analysis was built on the idea that teachers may already be implementing strategies or practices to promote dialogue in the math classroom. Again, the core phenomenon reposed on the notion of dialogue and the processes helping/hindering its emergence in the math classroom. Important to note at this stage, the emerging categories, and associated properties in relation to *outcomes* held temporary importance since it was conjectured that the outcomes would become more evident as the study progressed and as multiple forms of data were analyzed (e.g., subsequent workshop discussions, classroom observations).

Research Question 2: Investigating Teachers' Tacit Knowledge and Beliefs.

Corpora:	Emergent categories from open and axial coding (Interview 1), audio/video recordings and transcripts of workshops (W1+W2+W3), observational notes and memos, member checking with pedagogical consultants

	Coded segments represent 36% of the entire workshop data set. Coded segments primarily consisted of discussions during which multiple teachers and the consultant participated. The remaining 64% not coded included introductory discourse (e.g., first 30 minutes of Workshop 1), researcher-led presentation items, explanations of materials presented, and inquiries unrelated to the research question (e.g., technical difficulties connecting to the online platform, coordinating schedules and resources for classroom recordings).
Unit of Analysis:	The meaningful unit (as it relates to its pertinence to the research question) although mostly took the form of teacher turns in the case of interviews and episodes in the case of workshops.

Phase 2b: Axial coding (later stages). The discussions that took place during Workshop 1 were instrumental at this stage, not only to begin collaboratively exploring and co-constructing a shared notion of dialogue and productive dialogue in the math classroom, but also to clarify teachers' pre-workshop interview responses. This meant that axial coding continued in order to validate and/or clarify teachers' pre-workshop accounts of their experiences and perspectives and to further aid my understanding of the tacit factors (e.g., tacit knowledge and beliefs) influencing teachers' decision-making processes while organizing dialogue-intensive math tasks.

Phase 3: Selective coding and preliminary model building. Furthermore, the preliminary model considers pre-workshop interview responses and Workshop 1 discourse only as it was conjectured that these two complementary sources of teacher perspectives would mutually inform my understanding of teachers' (initial) tacit knowledge and beliefs related to dialogue in

the math classroom. Thus, the selective coding process metaphorically added flesh to bones as recurrent categories took form and "lived" in teachers' pedagogical discourse.

Phase 4: Theoretical saturation. Categories emerging in early stages of data analysis were examined in relation to teachers' contributions and questions arising during the workshop discussions as well as teachers' final post-workshop interview responses. It was not until analyses and the model had attained a certain level of stability that I then went back and forth between the data and theories of teacher learning and the development of dialogue-intensive pedagogies. This step served to provide possible explanations for emerging relationships while also being critical of the theories in the extent literature (i.e., confirming, refining, rejecting, or clarifying theories).

Research Question 3: Identifying Critical Professional Learning Trajectories.

Corpora:	Emergent categories and teacher responses (Interview 1 + W1+W2+W3), recordings and transcripts of Interview 2 (i.e., postworkshop interviews), ethnographic observations of classroom implementation
	Coded segments represent 74% of the Interview 2 data set. The remaining 26% not coded included exchanges that were unrelated to study (e.g., small talk) and linguistic fillers (e.g., yeah, um).
Unit of analysis:	The meaningful unit (as it relates to its pertinence to the research question) although mostly took the form of teacher turns in the case of interviews and episodes in the case of workshops and classroom observations.

In the final stages of data analysis, teacher implementations and final debrief interviews (i.e., open, axial, and selective coding, theoretical saturation) served to illuminate concrete instances of practice and change.

Analyses at this stage were primarily retrospective, aimed at looking back at how teachers recounted their experiences while participating in the study. Teachers' post-workshop accounts were essential to access teachers' views, perspectives, and challenges throughout the various iterations of the study. In this way, teachers' learning was traced back to specific moments, although conjectured to entail a progression of multiple moments. By tracing learning across the various study activities, it was conjectured that critical professional learning trajectories would emerge and provide essential evidence to further explain teacher learning.

Trustworthiness

Guba and Lincoln (1989) propose four strategies for assessing trustworthiness and rigour in qualitative studies—credibility, transferability, dependability, and confirmability. To attend to credibility, regular peer debriefing, memoing, and negative case analysis were conducted (Morse, 2015). Triangulating different data sources (individual interviews, workshop discourse, classroom observations) as well as different perspectives (researcher, consultant, teacher) also increased the depth of the analyses. Thick descriptions (Geertz, 1973) and, to a certain extent, theoretical saturation addressed issues of transferability. Additionally, reflexive research journaling and an audit trail were kept responding to issues of dependability and confirmability.

Close collaboration with two mathematics pedagogical consultants provided a local perspective of teacher learning issues and opportunities as well as providing an "insider perspective" essential to better understand systemic issues at the level of the school board. Relatively extended time with participating teachers along with multiple venues of

communication (e.g., email, online chat board via Teams) also provided additional sources of contact that aided exchanges necessary to understanding the teachers' contexts.

Researcher Positionality: An Evolving, Reflexive Stance

My positioning as a researcher evolved in relation to the different methods of data collected, ranging from interventionist (i.e., organizing and leading the workshops) to distant observer (i.e., viewing teachers' recordings of their classrooms). These multiple roles allowed me to take the most appropriate positioning in response to the multiple stakeholders participating in the study. For example, by instigating a professional development on dialogic pedagogy, I took away the substantial initial load often put on pedagogical consultants when creating, or co-designing, workshops in collaboration with researchers. This initiator position also allowed consultants to make choices about the material presented. The consultants' suggestions contributed to the arrangement of the materials presented and sometimes challenged me, as a researcher, to be mindful of the different roles and division of labor at stake. Teachers' agency also played an important role in the way I facilitated the workshops. By allowing teachers the freedom to choose whether and how they implement research materials, the study provides not only a more authentic approach to in-service professional development workshops, but arguably a more respectful stance by acknowledging that teachers are the best positioned to understand the realities of their classrooms and the workload represented.

To best support teachers during these processes of reflection and experimentation, I maintained an open and critical stance toward my own research-based materials: "As Bamberger and Schön (1983) noted, a 'reflective conversation' occurs 'between makers and their materials in the course of shaping meaning and coherence' (p. 69)" (cited in Bakker, 2018, p. 212). While I have trust in the materials presented, I also acknowledge that meanings inherent in these

research-based findings, like any form of communication, are not immune to miscommunication and misunderstandings. Voice and authority play a large role in any social sphere and particularly in partnerships between research and practice (Vedder-Weiss et al., 2020). For this reason, I maintained my role as a novice researcher in educational psychology, while not being completely disconnected from teaching and mathematics myself. For instance, I taught several years as an EFL teacher abroad and completed a non-negligible amount of mathematics during my undergraduate studies with a minor in mathematics. Overall, I respected participants' competence as experts in mathematics education and enthusiastically welcomed pedagogical consultants' contributions as mediators between research and practice.

Chapter 4: Findings

This study aimed to explore teachers' perspectives, tacit knowledge, and beliefs on dialogue in the math classroom. Individual interviews and group workshops provided multiple opportunities to explore teachers' self-reported and situated understandings of dialogue for learning.

Research Question 1: Exploring Teachers' Experiences and Perspectives on Dialogue for Learning

Teacher Characteristics

Advanced Teaching Expertise and Support. Well before line-by-line analyses took place, there were three particularly noteworthy observations made at the outset of the study. First, nine out of 12 of participating teachers had 14 or more years of teaching experience (M = 15.33 years, SD = 6.62 years). This observation suggests that the topic and nature of the study effectively attracted expert teachers.

Second, all the participating teachers except one had a notable link with pedagogy for students with learning difficulties. In other words, teachers described their education, current context, or experiences as having close connections with teaching practices that actively seek ways to support students with learning or behavioral difficulties. Four of the teachers were specifically trained to instruct students with special needs (*en adaptation scolaire*). Additionally, six teachers described adaptive approaches (e.g., Response to Intervention, RTI) or specific classroom contexts in which they were led to regularly facilitate students with learning and behavioral needs, whether at a cognitive level (e.g., development of autonomy, language development) or at a social level (e.g., socioemotional needs).

Finally, half of participating teachers described the regular presence of another educational professional (e.g., team teacher, resource teacher) during the time of the study and/or prior to COVID-19. Five of the teachers were also currently supervising a student teacher. It should be noted that teachers in Quebec are not systematically assigned resource teachers or team teachers—one reason being due to the shortage of educational staff in Quebec—the presence of additional adult support could be a significant factor characterizing this group of teachers and even influencing teachers' willingness to participate in research in the first place.

Emerging Patterns in Teacher Dispositions. The teachers' initial interview responses were examined more holistically to identify potential patterns in teachers' discourse. Patterns and idiosyncrasies were identified to better understand the participating teachers' practices and perspectives. Three broad dispositional categories emerged: first, there were teachers who described themselves as creative or as having flexible teaching practices; second, other teachers characterized their practices as structured or methodical; finally, another group of teachers shared that they were unsure of the efficacy of their practices. While characteristics defining these groups were not mutually exclusive, one of the preliminary questions concerned whether these patterns would later be associated with observations emerging from the data. At this time, all possibilities were kept on the table.

First, two elementary teachers and one secondary teacher could be described as creative and flexible, having a high level of confidence in their pedagogical content knowledge. For example, this group of teachers described what could be interpreted as pedagogical expertise that allowed them to structure their routines while being creative and open to being surprised by whatever students came up with during classroom discussions. This confidence was consistent with teachers' decision to abandon exercise books, to be confident and flexible during classroom

interactions, and most importantly, to be reflective and self-critical with regards to their own practices.

> I have got so much math stuff that comes from so many different directions for so many different things that I—I can very easily stop the class midstream and switch from pictures to manipulatives and they're there. (Vicky, Interview 1)

I am a person who loves to invent, who loves to create, so that from year to year (1.5) I continually change my activities and then improve them. Sometimes I pull out old activities that, you know, that we forget, you know, with time, 'Ah yes, that, that had worked.' But I think a lot of that it's my teaching path ((*in special education*)) which maybe makes it that (.) I am a less traditional math teacher (Valérie, Interview 1)	Je suis une personne qui aime inventer, qui aime créer, fait que d'une année à l'autre (1.5) je change continuellement mes activités, puis je les améliore. Des fois je ressors des anciennes activités que, tu sais, qu'on oublie là, avec le temps là, 'Ah oui, ça, ça avait fonctionné.' Mais je pense beaucoup que c'est mon mon parcours d'enseignement là ((*en adaptation scolaire*)) qui fait peut-être que (.) je suis une enseignante de math moins traditionnelle là. (Valérie, Interview 1)

The second pattern observed concerned two secondary teachers who could be described as having a highly structured or methodical approach. In contrast to the first group, both teachers had no aversion to using exercise books or premade materials and highly valued step-by-step instructions. This approach was positively reinforced in teachers' own classrooms the more they observed student motivation grow with instructional clarity.

The objective really needs to be clear because as soon as it's a little bit fuzzy, (2.0) here, you just have to ask yourself questions, they come to see you and then, no one is moving forward. There really has to be a (.) You know like earlier when I was saying, 'You were following on the Smart Board, which I showed. Okay, find there'—you know it really pays off because I guided [them] step by step. Then I got to where I wanted to go. Then the kids really, really, really enjoyed the activity, you know. They really found it interesting, then I think (1.5) it's really the goal has to be clear. Even if it is (.) a little fuzzy, it will not work. (Caroline, Interview 1)	Faut vraiment que l'objectif soit clair parce que moindrement que c'est un peu flou, (2.0) là il faut juste se poser des questions, ils viennent te voir puis, y a personne qui avance là. Faut vraiment qu'il y a un (.) t'sais comme tantôt là quand je disais que, 'Tu suivais sur Smart Board là, que j'ai affiché. Okay, là, trouve là'—t'sais là c'est vraiment payant parce que là j'ai j'ai guidé pas à pas. Puis je suis arrivée où est-ce que je voulais arriver. Puis les élèves ont vraiment, vraiment, beaucoup apprécié l'activité là, tu sais. Ils ont vraiment trouvé ça intéressant, puis je pense que (1.5) c'est vraiment faut que l'objectif soit clair. Moindrement que c'est (.) un peu flou là, ça fonctionnera pas. (Caroline, Interview 1)

Finally, a third pattern stood out that could be described as an unsureness in teachers' own practices. This observation concerned four elementary teachers and one secondary teacher. Three elementary teachers openly admitted to being somewhat unsure of their practices.

But you never know if what you're doing, is is, if it's actually good, (if) it's right after all. (Cindy, Interview 1)	Mais c'est qu'on sait jamais si ce qu'on fait, c'est c'est, c'est réellement bon, (si) c'est correct dans le fond. (Cindy, Interview 1)

This group of teachers often went into lengthy and detailed descriptions of their practices, even when not prompted, which could be interpreted as a way to justify their approaches or to foreclose any doubts regarding their competency. The two teachers having the least amount of teaching experience compared to the other participating teachers were in this group. It is possible that this final group felt an unsureness about their practice vis-à-vis the research(er) (e.g., unfamiliarity with research, or even a perceived power dynamic) as much as it could be linked to a lack of confidence overall. However, supplementary information suggests that the former may be more likely (i.e., unsureness vis-à-vis research) given that all of the teachers responded similarly to teaching efficacy questions. Specifically, when asked to rate on a 5-point Likert scale how confident teachers felt in their ability to facilitate productive discussions (1=not confident at all, 5=very confident), these five teachers were no less confident in small group contexts (M = 3.9, SD = 0.49) compared to confident and structured teachers (M = 3.9, SD = 0.89). Also, when the context changed to whole-class discussions, there were no notable differences between this group's level of confidence (M = 3.6, SD = 0.49) compared to that of confident and structured teachers (M = 3.6, SD = 0.82), although average confidence levels were lower overall in whole-class contexts opposed to small-group contexts.

Open Coding—Conceptualizations of Dialogue, Productive Dialogue and Successful Dialogue

Within the first sub-sample of interviews (n = 10) targeted for line-by-line analysis, 14 potential categories, 65 sub-categories and 729 codes emerged from the data during the initial open coding phase (see Appendix G).

When asked what comes to mind when they hear the word "dialogue", teachers gave a wide range of responses (see Table 5). Despite the variety of responses, two sub-categories emerged: student-centred dialogue and teacher-mediated dialogue. While student-centred dialogue focused on student sensemaking and interactions more broadly, teacher-mediated dialogue focused on the teacher's role in ensuring that dialogue emerges in the classroom.

Table 5

Phase 1—Teachers' Conceptualizations of Dialogue in the Math Classroom

CATEGORY/**Sub-category**/Code	**# of teachers**	**Code frequency**
DIALOGUE		41
Student-centred dialogue	**7**	**17**
Students (opposed to the teacher) are doing the talking/sensemaking		8
Students help one another		4
Everyone's voice is heard		3
*Personality issues impede learning objectives		2
Teacher-mediated dialogue	**8**	**24**
Teacher schedules work, sets up environment to encourage class exchanges		10
Teacher shows interest in students' lives, makes math fun		6
Teacher adjusts to students' level, helps students develop confidence/trust		5
Teacher leads students to be responsible for learning		2
*In math, it's like "pulling teeth"		1

Note. Negative case analyses (*) reveal instances that contradict or qualify the sub-category/code.

For example, teachers conceptualized dialogue as adjusting to students' level through, for example, vulgarizing mathematical terminology. Teachers also described how they aim to connect with students' lives and try to make math fun.

These two sub-categories reveal important nuances in teachers' beliefs regarding the role of both teachers and students in participating in and maintaining dialogue more generally and specifically in the math classroom. Also, most of the teachers' conceptualizations of dialogue were not markedly student-centred or teacher-centred, with the exception of four teachers whose descriptions of dialogue were more categorical. For instance, one elementary teacher's descriptions were student-centred, while two secondary teachers' and another elementary teachers' descriptions could all be described as focusing on the teachers' role in the emergence of classroom dialogue.

None of the teachers were familiar with the expression "dialogic teaching" nor with its underlying principles. Some of the teachers, through guessing, mentioned some relevant points. However, their guesses were largely influenced by the topic of the research study itself as well as their responses to prior questions on dialogue and productive dialogue.

Furthermore, it could be said that teachers' knowledge of student learning was challenged when asked to describe a "productive" dialogue in the mathematics classroom (see Table 6). Teachers often framed their response around a behavior that they wanted to see, but without linking these behaviors to student learning. Four broad sub-categories emerged: verbal/interactional signs of productivity, mediated productivity, outcomes as productivity, and non-verbal signs of productivity. Teachers (n = 8) who associated verbal/interactions with productivity described: students' explaining their own or others' thinking, openness to others' ideas, asking questions and challenging one another's ideas, and working toward a common goal.

Table 6

Phase 1—Teachers' Conceptualizations of "Productive" Dialogue in the Math Classroom

CATEGORY/**Sub-category**/Code	**# of teachers**	**Code frequency**
PRODUCTIVE DIALOGUE		55
Verbal/Interactional signs of productivity	**8**	**21**
Students explain their own/others' thinking, describe multiple perspectives		8
Students are open to others' ideas, ask questions/challenge		8
Students work toward common goal		5
Mediated productivity	**7**	**15**
Mediated by teachers' presence/intervention		8
Mediated by tools/manipulatives/simplified terminology		5
Mediated by time		1
Mediated by respect developed through talk activities		1
Outcomes as productivity	**5**	**5**
Conversation that leads somewhere more advanced than before		2
Students find answer/relationships by themselves		2
Confidently writing out steps on written tests		1
Non-verbal signs of productivity	**5**	**14**
Something that happens in eyes		6
Difficulty describing what productive dialogue is		3
Something you can feel, collective excitement		2
Willingness to admit when wrong		3

Teachers who associated the teacher's interventions as a key element of productive dialogue could be divided into two sub-groups: teachers (n = 2) providing "structured" responses and teachers (n = 5) providing "implicit" responses. Teachers who provided structured responses tended to mediate dialogue using tools, manipulatives, or simplified terminology. In contrast, teachers who provided implicit responses tended to encourage students to think about their answers and respond without worrying if their answers are correct or incorrect. Sometimes these teachers did not respond to the question at all, describing instead what productive dialogue is not

(too much silence, students do not move, students are using an inefficient strategy), with some indications on how they might remedy this. For example, one elementary teacher described how she encourages students to retrace their own logic:

(when) he says to me, 'I don't understand anything,' it's like the easy sentence uh for children (.) very often, I'll go like (.) in reverse. I'm going to ask him, 'Perfect. Tell me what you understand and we'll start from (1.5) where we are at.' (2.0) Of course, I have seen results with several students to (.) proceed in this way because they often answer their own questions (2.0) by explaining. (Cindy, Interview 1)	(quand) il me dit, ‘Je comprends rien,’ c’est comme la phrase facile euh pour les enfants (.) bien souvent, je vais aller comme (.) à l'inverse. Je vais lui demander, ‘Parfait. Dis-moi ce que tu comprends et on partira de (1.5) de là où on est rendu.’ (2.0) C'est sûr que j'ai vu comme des résultats avec plusieurs élèves à (.) procéder de cette façon-là parce que souvent, ils se répondent eux-mêmes (2.0) en expliquant. (Cindy, Interview 1)

Five of the focal teachers (four elementary, one secondary) referenced outcomes or goals associated with productive dialogue (e.g., students find answers by themselves on a task or test), and five teachers (four elementary, one secondary) went on to describe non-verbal signs of productive dialogue, describing instances of collective excitement or something that lights up in students’ eyes:

Productive? Well when I, when I see it lights up, it looks like it lights up in students’ eyes. (Julie, Interview 1)	Productif ? Ben quand je, quand je vois c'est ça s'allume, on dirait que ça s'allume dans les yeux des élèves là. (Julie, Interview 1)

When asked about small-group task routines and practices, most of the teachers' responses vaguely connected small-group interactions with the concepts of dialogue or productive dialogue (see Appendix H). Only two teachers (one elementary, one secondary) explicitly linked the concept of dialogue to small-group tasks.

Nonetheless, all the participating teachers believed that small-group activities could benefit student learning. Eight teachers regularly organized small-group activities in their classrooms. When asked to describe their small-group (or group activity) routines, all of the teachers, even those who did not organize small-group tasks regularly, were very articulate in the way they described their small-group strategies (e.g., group formation, task components, routines for behavioral management and autonomy development) and the reasons why they implement them (e.g., to encourage students to verbalize their thinking in math, to achieve specific math learning goals, to motivate students).

I inquired about the frequency at which teachers' colleagues implement small-group tasks, and two observations stood out. First, six teachers (four elementary, two secondary) believed that their colleagues (outside of the study) implemented small group tasks less frequently than they did. Amongst these teachers, two (one elementary, one secondary) described their colleagues' practices as akin to parallel work rather than genuine collaboration. A second observation emerged, that the participating teachers who worked alongside and planned lessons with their colleagues (n = 4) all adopted the same approaches. This included whether to integrate (or not) small-group activities into common practice. Two noteworthy obstacles to integrating small-group activities in collective lesson planning stood out—teachers' lack of habit (i.e., teachers simply do not organize small groups often enough to develop a routine) and high teacher turn-over (i.e., teachers do not have the opportunity to establish collective routines).

When teachers were asked to describe how they decided when or whether small-group activities were "successful", teachers' discourse intuitively transitioned from a process-oriented discourse (as was observed within teachers' accounts of "dialogue" and "productive dialogue") toward a progress-oriented discourse. Specifically, teachers' descriptions centred around students' progress in the activity and students' written task performance/autonomy. It was also worthy of note that non-verbal signs again played an important role in four of the teachers' accounts.

There was an unexpectedly high rate of unsolicited demonstration of knowledge regarding students' metacognitive processes and how teachers actively promote them (see Appendix I). These descriptions were mentioned within the context of discussion-based practices, specifically within their descriptions of their small-group routines. One may observe the relatively high frequency of attention to goal setting, which contrasts the relatively low attention to explicit monitoring and reflection. Indeed, only two elementary teachers (Vicky, Sarah) described practices whereby students attend to progress checking and reflection.

Early Stages of Axial Coding—Pedagogical Knowledge for Successful Implementation of Small-Group Tasks

While all participating teachers held a positive view of small-group activities for learning, teachers conserved a cautious discourse around their adoption. A first cautionary theme centred on the amount of time and energy required. Six of the participating teachers considered small-group tasks as a particularly challenging environment to plan and implement. Three teachers also highlighted the need to set up group norms before small-group tasks can be successful.

A second theme emerged around student/group-specific considerations. Disparate classroom composition, students' lack of autonomy, or dominating personalities of some students overpowering others' voices were cited as potential inhibitors of positive small-group environments. Consequently, almost all of the teachers (n = 8) underlined the importance of classroom management for successful small-group tasks. These themes (time/energy, group norms and classroom management) speak to the importance of having a solid foundation in pedagogical knowledge (PK).

The third theme speaks to teachers' pedagogical content knowledge (PCK), specifically concerning the alignment of task and learning target. During pre-workshop interviews, teachers recounted the importance of choosing tasks that allow students to have open exchanges about their thinking, to reflect on their own learning, and to better understand math concepts. In tension with this idea, two elementary teachers described the difficulty of finding "good" math tasks that challenge students while accommodating different competency levels.

Only two teachers mentioned the subject matter as a potential factor influencing the ease of integrating small-group tasks into teaching practice more generally. One elementary teacher described the relative ease of encouraging lively participation in English compared to math discussions, saying that "in math, it is a little bit like pulling teeth (laughs)" (Vicky, line 58). A secondary teacher described the difficulty of planning small-group tasks while being conscientious of the high stakes involved in passing Ministerial exams:

[…] I think that there is a great pressure that comes, that we have a Secondary 4 Ministry examination which is (.) preliminary to having the the the (.) high	[…] je pense qu'il y a une grosse pression qui vient, qu'on a un examen du ministère secondaire 4 qui est (.) préalable à avoir le le le (.) la diplomation. Puis qu'on a des

school diploma. Then we have some students in great difficulty. Then sometimes I think it's as if we thought they were learning less when they were in subgroups or doing an activity or in, umm (.) which is totally the opposite. (Céline, Interview 1)	élèves en grande difficulté. Puis des fois, je pense que c'est comme si on pensait que ils apprenaient moins quand ils étaient en sous-groupes ou en activité ou en, umm (.) ce qui est totalement contraire. (Céline, Interview 1)

In essence, Céline shares the contradiction that she perceives how one may believe that putting students in small-group activities is somehow less productive or less relevant to student learning.

Given the singularity of the environment in which teachers were interviewed (i.e., COVID-19), pandemic-related constraints also arose in teachers' discourse. The most obvious constraints included the safety measures implemented to curtail the spread of the virus. This included physical distancing that demanded adaptations in schools and classrooms, notwithstanding the temporary interruption of all group activities involving close physical proximity. Once mask mandates and other health measures were mandated, implemented, and generalized, teachers were able to use small-group activities once again, to the extent that students remained in their "classroom bubble" (*classe bulle*). These regulations further evolved as the government responded to epidemiological studies and as vaccination campaigns progressed, creating both opportunities and uncertainty as teachers tried to remain flexible in response to a rapidly evolving situation. Furthermore, schools and classrooms were frequently subject to unexpected, immediate classroom and in some cases school closings. These circumstances caused concern that teachers might not be able to be as implicated in the research project as they might have hoped.

Additionally, teachers recounted how their pedagogical routines were interrupted due to the pandemic. Some of the teachers had to suspend team teaching, which, according to them, made it more difficult to organize small-group tasks routines that they had developed within a team-teaching environment. Teachers also recounted the effect of working from home on students' socioemotional well-being (e.g., lack of accountability, students are not kind to one another). One teacher also recounted the change in professional development initiatives proposed by their school board during the pandemic (i.e., prioritizing topics related to online instruction over pedagogy). More telling yet, one teacher recounted how there was a general pressure felt by teachers in her school board to "pretend" that valuable learning happened online, and that it was now the responsibility of teachers to "catch up".

It must be said that, given these organizational changes (challenges) and the associated pressure felt by teachers, the fact that teachers and school boards were willing to participate in this study was a testament to the perceived value of this type of research activity.

Research Question 2: Tacit Factors Emerging in Teachers' Pedagogical Discourse

Teachers' impromptu discussions on various topics of interest (e.g., dialogic teaching, collaboration and metacognition, and quality tasks) revealed different challenges that teachers experience in their practice as they endeavored to put into application their knowledge. These discussions brought to light their tacit knowledge, beliefs, and other factors directly influencing the emergence of dialogue in their classrooms.

Three categories emerged in teachers' discourse over the course of the workshops and classroom experimentation. Initially, these categories were labelled *student special needs/personality*, *emotional concerns*, and broadly what entails *"good" math tasks* for productive dialogue. These three categories evolved as the workshops progressed, shifting to: (a)

teachers' attention to the notion of *uncertainty*, specifically how teachers perceived or attended to uncertainty during classroom discussions; (b) *emotional dynamics*, including both teachers' and students' emotions, throughout the process of communally learning how to participate in dialogue in the mathematics classroom; and (c) strategies for transforming research-based materials into *actionable tools and tasks* to support a culture of dialogue in the mathematics classroom and in teachers' practice more broadly. It is worth noting that these themes played a direct role in teachers' decision to accept, to question and, in some instances, to reject the research-based resources. The emergence of these categories and how they evolved with the workshop activities and classroom experimentation are described in detail below.

Emotional Concerns and the Teacher's Role. The first observation made concerns the important place that students' emotions played in the participating teachers' analysis of dialogue. When presented with an example of student group work in the form of a vignette, *students' feelings* took centre stage in teachers' discourse. Teachers were tasked with discussing the place of dialogue and the potential to learn offered to students in a group characterized by one dominating voice. Essentially, the vignette shows an eighth-grade student, Angela (pseudonym), taking it on herself to lead her teammate's math activity. Without any cues from the teacher or her fellow classmates, she begins telling her teammates what to do. Teachers' initial reactions were largely the same: there was no place given to dialogue in this group.

Julie: Oh I'm piggy backing on your idea too, maybe the other two aren't happy. If it was a team (based on) choice, maybe they're just not happy to be with her who just decided 'No I'm not participating.	**Julie:** Ah je fais du pouce sur ton idée aussi, c'est peut-être que les deux autres sont pas heureux. Si c'était une équipe au choix sont peut-être pas contents d'être avec elle qui ont juste décidé 'Non je

Figure it out yourself sister because' (laughs). (Workshop 1, Group 2 Primaire, [00:48:48] - [00:48:58])	participe pas. Arrange-toi ma grande parce que' (laughs). (Workshop 1, Group 2 Primaire, [00:48:48] - [00:48:58])

However, other teachers' reactions to the prompt were less categorical. For example, Sarah (Group 1) suggests that a dominating voice is not necessarily problematic in instances where lower performing students are able to glean some useful information from the interactions.

> **Researcher:** Okay, so for you (Sarah) um and correct me if I'm wrong. Or you know, add to what I want to the next comment. If--would you saying that even if there's a dominating voice like Angela, it's still a good task, or the students still have opportunities to learn from it, even if maybe there's some unequal participation?
>
> **Sarah:** Yes, I think so. Especially for the weaker ones, or the ones who don't like to speak. (Workshop 1, Group 1 Elementary, [00:39:42] – [00:40:10])

In contrast, a larger proportion of teachers (n = 5) insisted instead on the *teacher's role* in ensuring that groups are formed to delegate roles and thus to curtail any negative interactions. In these instances, teachers' comments tended toward a noteworthy emphasis on student personality.

Céline: That there is one who takes the lead, who is, who is, who is better than the others, will take the lead, then the others will wait for the other to produce. So when the role, it is not determined, of of, of each of them what is expected of them.	**Céline:** Qu'il y en a un qui prend le lead, qui est, qui est, qui est meilleur que les autres, va prendre le lead, puis les autres vont attendre que l'autre produise. Fait (que) quand le rôle, il n'est pas déterminé, de de, de de chacun de ce qu'on attend

(Workshop 1, Group 3 Secondaire, [00:41:49] – [00:41:59])

d'eux. (Workshop 1, Group 3 Secondaire, [00:41:49] – [00:41:59])

Audrey: And I think that goes back to how the groups are made, more so than how the norms are set up. So there's kind of maybe, maybe two things at play. (Workshop 1, Group 1 Elementary, [00:37:27] – [00:37:34])

Regardless the generally held view that having one dominating voice is not ideal, teachers nonetheless tended to empathize with the example groups' teacher, imagining their own students in the place of the directive/dominating student, Angela.

Researcher: (laughs) So let's talk about Angela. (laughs) Julie, what, what do you think?

Julie: Well, I can put names of students, there, I could change it differently and it would be another first name that I would put. But it's. She decides for everyone else, yeah. There is like no place. There is a leader but she decides everything.

Cindy: There's no more room for dialogue after all because like she decides, 'you, you do that, you, you do that,' there is not (2.0) / (inaudible)

Researcher: (laughs) Alors parlons-en de d'Angela. (laughs) Julie, qu'est-ce que, qu'est-ce que t'en penses ?

Julie: Ben moi je peux mettre des noms d'élèves, là, je pourrais changer ça autrement que ça serait un autre prénom que je mettrais. Mais c'est. Elle décide de tous les autres, ouais. Il y a comme pas de place. Il y a une leader mais elle décide de tout.

Cindy: Il y a plus de place au dialogue dans le fond parce que comme elle décide, 'toi, tu fais ça, toi, tu fais ça,' y a pas (2.0) /(inaudible)

Mélissa: / They don't learn / so much, they don't learn together. And there she knows what to do. Then the others, they are going to do what she tells them, so they don't learn together.	**Mélissa:** /Ils apprennent pas/ tellement, ils apprennent pas ensemble. Et là elle sait quoi faire. Puis les autres, ils vont exécuter ce qu'elle va leur dire, donc ils apprennent pas ensemble.
Researcher: Mm. ((*Nods head*))	**Researcher:** Mm. ((*nods head*))
Cindy: Me too I can put names for example.	**Cindy:**Moi aussi je peux mettre des noms par exemple.
Mélissa: Yeah me too.	**Mélissa:** Ouais moi aussi.
Julie: (laughs)	**Julie:** (laughs)
Patricia: (laughs)	**Patricia:** (laughs)
(Workshop 1, Group 2 Primaire, [00:46:05] - [00:46:50])	(Workshop 1, Group 2 Primaire, [00:46:05] - [00:46:50])

In contrast to these two emerging categories, a third category emerged, *student learning through scaffolded talk*. Rather than seeking ways to cater to student personalities or to avoid negative interactions, two teachers (one elementary, one secondary) focused on modeling behavior and making connections between teachers' pedagogical knowledge/practices and evidence of student learning.

> **Vicky:** Yeah, I'm not sure like they. In the task itself all the way they they're their dialogue or not, lack of it is, you know, you could probably tell that Liz and Terrence can calculate area and know what area is, but there's no evidence that there because Angela takes over that, they've actually taken that from the 2D to the 3D 'cause she's just done that part for them. (1.5) So I'm not sure whether, you know, prior knowledge

is just being reinforced for those two, or are they learning that next step? (Workshop 1, Group 1 Elementary, [00:41:31] – [00:42:05])

Valérie: Well, the other thing that I also observe is that often the students have not been accustomed to collaborating for real, in teamwork. I think we talked about it during the interview, so you know there is a difference, I think, if the teacher—yes, it can depend on the tasks, but otherwise, the teacher also announced it, presented modeled maybe what it was to really work in collaboration and not teamwork where each one does his part of the job. (Workshop 1, Group 3 Secondaire, [00:43:52] – [00:44:22])	**Valérie:** Ben l'autre chose que j'observe également, c'est que souvent les élèves ont pas été habitués non plus à collaborer pour vrai, en travail d'équipe. Je pense qu'on en avait parlé lors de l'entretien, donc t'sais il y a une différence, je pense, si l'enseignant—oui, ça peut dépendre des tâches, mais sinon, l'enseignant a également annoncé puis, présenté modelé peut-être c'était quoi réellement dans le travail de de collaboration et non un travail d'équipe où chacun fait sa sa partie du travail là. (Workshop 1, Group 3 Secondaire, [00:43:52] – [00:44:22])

Appropriating a Dialogic Discourse. Following the open interaction analysis described above, teachers were given another interaction analysis to do (a second vignette), this time guided by specific types of talk shown in the research literature to be essential components of productive dialogue in the classroom (i.e., all group members are actively *Participating*, *Building* on one another's ideas, and *Challenging*/questioning one's own and other's ideas). The second example of student work was drawn from one of the participating teachers' previous

collaborations with my supervisor's research. Express permission was requested from the participating teacher before presenting the example in the workshops. Neither the teacher nor the students' faces were shown in the vignette. The second example of group work was announced as a contrast to the first example shown, though with the intention of showing an example of student participation that was more symmetrical than the first example.

Interestingly, teachers in both primary groups (Groups 1 and 2) began by critiquing the example of student work, using the vocabulary learned from the research.

> **Vicky:** (6.0) I think when we looked at the productive talk moves, I think they are building on each other's ideas. Um and they are helping each other build on their ideas. But then they don't challenge or question each other's answer. (Workshop 1, Group 1 Elementary, [00:58:09] – [00:58:20])

Cindy: Of course there is more of a dialogue, but at the same time I don't see one, maybe it's me (but) I feel like I'm not having a discussion here, I feel like I'm seeing students who say 'we have to do that' and have no questions about 'Well I'm not sure' or 'How do we transform.' So at the level of the discussion on 'I think we should do this because' or 'I don't see that each', students are discussing, 'we have to do that, after that, after that, after	**Cindy:**C'est sûr qu'il y a comme plus un dialogue, mais en même temps je vois pas une c'est peut-être moi là j'ai l'impression de pas avoir une discussion, j'ai l'impression de voir des élèves qui disent 'on doit faire ça' et a pas de questionnement sur 'Ben je suis pas certain' ou 'Comment on transforme.' Donc au niveau de la discussion sur 'je pense qu'on devrait faire ça parce que' ou 'ça je le vois pas chaque', y a des élèves

that', but at the construction level I I don't feel like I'm getting that. (Workshop 1, Group 2 Primaire, [01:00:37] - [01:01:09])	qui discutent, 'on doit faire ça, après ça, après ça, après ça,' mais au niveau de la construction j'ai j'ai pas l'impression de sentir ça. (Workshop 1, Group 2 Primaire, [01:00:37] - [01:01:09])

These critiques began a dialogue between the teachers, the pedagogical consultants, and me about ways that teachers can use these types of "dialogic moves" (*Participating*, *Building*, *Challenging*) as a starting point to better assist the way teachers scaffold productive dialogue and to ensure that students have a higher chance of learning together during group activities. More importantly, the guided interaction activity and following dialogue ensured that teachers in Group 2 also had an opportunity to discuss student learning through scaffolded talk, a subject that emerged more naturally from teachers' tacit knowledge in Groups 1 and 3.

It was interesting again to observe that the talks on research-based materials did not appear to be provocative enough to warrant any obvious change in teachers' discourse about dialogue or productive dialogue. In fact, a few of the teachers used these talks to confirm that they were already doing the targeted practices shown, that example students were productive even if using a majority of nonverbal interactions (and inherently diverting attention away from research-based talk moves), and in more extreme cases, that proposed activities/practices would not work for their students/classes. For example, one secondary teacher in Group 3 focuses again on her students' learning difficulties and personalities.

Céline: /Oh yeah. Yeah, /that's it. It really depends on the composition of the groups. You know, for sure when we have	**Céline:** /Ah ouais. Ouais./ C'est ça. Ça dépend vraiment de la composition des groupes. Tu sais, c'est sûr que quand on a

more heterogeneous groups, with stronger ones, it may be more difficult to engage all the students, uh. You know in the groups that I share with (name of team teacher), for us, we principally have students with great (learning) difficulties. […] It will be worth trying because I don't know even if they are in a small group if if it is part of their personality even if it they were in a group of three or two. Well maybe two yes. But with three would that imply would they be able to impose their ideas? Sometimes it's more about their personality, I would say that they do less, whereas if I had one of the really heterogeneous groups with the strongest, the weakest, surely the weakest wouldn't have a tendency to want to answer you know.

(Workshop 1, Group 3 Secondaire, [01:05:17] - [01:06:19])

des groupes plus hétérogènes, avec des plus forts, c'est peut-être plus difficile de de de d'aller chercher toutes les élèves, euh. T'sais dans les groupes que je partage là avec (nom d'enseignante team teacher), nous c'est des groupes avec des élèves principalement avec des grosses difficultés. […] ça sera à essayer là parce que je sais pas même s'ils sont en petit groupe si si ça fait partie de leur personnalité même s'ils étaient en groupe de trois ou de deux. Ben peut-être deux oui. Mais de trois est-ce que ça impliquerait est-ce qu'ils seraient capables d'imposer leurs idées ? Des fois, c'est plus à la valeur de personnalité, je dirais que qu'ils font moins, tandis que si j'avais un des groupes vraiment hétérogènes avec les plus forts, les plus faibles, sûrement que là les plus faibles aurait pas tendance à vouloir répondre là t'sais.

(Workshop 1, Group 3 Secondaire, [01:05:17] - [01:06:19])

Here, classroom management knowledge and emotional/personality concerns appeared to be indissociable from teachers' beliefs, particularly their role as a teacher. For example, when teachers discussed the first example of student group work, teachers largely agreed that Angela's group work behavior was less than ideal. Teachers even proposed examples of pedagogical strategies they would use to plan tasks similar to those described, though with the intent of adapting the environment to change the behaviors shown (e.g., grouping strategies). Behind these group strategies lay two implicit questions: first, whether group work should be conceptualized as smaller units of the class (but still reflecting the whole) or as clusters of individual students; second, whether teachers *should* curtail all possible negativity between group members, removing students away from any potential form of conflict. Another unsaid question emerged whether teachers should necessarily encourage all students to talk during group work. This idea emerged when one elementary teacher insisted that non-verbal interactions were just as valuable (and arguably more valuable) than verbal interactions, even when presented with compelling evidence from research that particular types of verbal interaction can promote deeper learning.

In particularly poignant examples of challenging classroom environments, two teachers in Group 1, described the negative experiences that they had been having this past year with their classes. Even when a fellow colleague suggested some concrete activities they could try, these teachers remained skeptical, one teacher even sharing how she had tried similar activities but did not observe the desired behavioral change. For this reason, this teacher (Sarah) expressed how she was looking forward to the metacognitive/self-regulatory topics planned within the next workshops.

Sarah: Yeah, I think for myself, which is workshop number two is how to get some of the students to self-regulate themselves. A lot of them you know, will go off it or.

Students and making sure they create a safe space for others too. You're trying to create a safe space but I find this year they're very rock and roll, and it's a challenge to create a safe space for everyone and I'm find—I'm having a hard time with that this year. (Workshop 1, Group 1 Elementary, [01:33:56] – [01:34:19])

[…]

Vicky: Would it? I don't know. Would it be possible? Would it work to, when you're initially starting dialogue with the students to maybe like create roles like we do for literature circles? […] then have them switch roles so that they're all having, they've got a specific job and they've got sentence starters for you know that specific part of the conversation just to get them actually talking? I don't know. Would that work for math?

Sarah: Well, I started using sentence starters so they would each have something to say, so that's helped and I've tried to keep their groups the same for at least like a month or two so they get comfortable. But then I'm sure when I switch it's gonna be like what you were saying Audrey. That is like, 'Okay we have to start it.' It's just hard. So yeah, I know the sentence starters have helped a lot. But it's still. Not the easiest this year.

Vicky: Okay.

Researcher: These are tough things. What do you, what do you think Audrey? Is this something that you you could that you've tried? Or you could try in your own classroom? This, um, the the roles, getting students started with this. Maybe some example sentences that kind of help them get into their role. Is that something you've tried or could try?

> **Audrey:** In my fifth grade class it would be fantastic. Those are the kids that are like they just eager to learn all the time. In sixth grade it's really a really has very little to do with learning a lot to do with personal situations that are very, very heavy for a handful of kids, but that handful is. It's dragging us down man (laughs) like. And that's okay, like I, I'm aware that it's a temporary thing. It's specific to this group of students and. We're just gonna have to do the best we can and keep going, uhm. Because we're having a lot, they're having a lot of trouble together socially outside of class. So of course, inside of you know, within the classroom is difficult as well. So I'm thinking it's pretty temporary, but I do. I do like the idea of exploring roles as well, especially when starting out. It gives a very concrete thing to hang onto, so to speak. So.
>
> **Researcher:** Sarah, you were about to say something.
>
> **Sarah:** No, yeah I. I can relate to what she's saying like it's like war outside of the class and then to try (haha) get it all nice and har harmonious in the class. But yeah, the roles have helped but uh. Yeah, it's just hopefully that that year and (inaudible). I've never yeah, depends on the class. (Workshop 1, Group 1 Elementary, [01:36:21] – [01:38:46])

What's more, the pedagogical consultants (Patricia and Sophie) played an important role in these conversations. In Groups 2 and 3, Patricia and Sophie, respectively, used this occasion to talk about the reference manual for math instruction and provoked further discussions about ways to promote not only classroom norms but a better learning climate for students' learning. The pedagogical consultants highlighted the coherence between the materials shown and the new reference manual. Teachers in the primary groups even used this occasion to share specific strategies that they had implemented to promote positive group behaviors in line with the

discussion on productive dialogue. In this way, teachers in the primary groups, particularly in Group 2, began to not only respond to the research-based activities, but to participate in their own learning dialogue—actively participating, challenging, and building on one another's ideas. But again, as shown earlier, these conversations did not appear to significantly change teachers' perspectives, if only to show them that they may need more support in implementing these practices than perhaps initially expected, whether through the research lens of productive talk moves or through the pedagogical consultant's assistance in identifying dialogic classroom norms.

Patricia: For me, just to build on one or two slides you showed before. You were talking about class climate, caring and all that. Just really quickly girls. This is in the essential conditions so that mathematics can be done in class according to the reference manual for interventions in mathematics. There are two conditions, one of which is that it has to have a class climate precisely with that, where we have caring, collaboration, criticality and room for creativity. So this is directly related to what is required, what is suggested in the reference manual as such. But indeed, in any case, as for me, to	**Patricia:** Moi, juste pour faire du pouce sur une ou deux diapo que t'as fait avant. Tu parlais de climat de classe, de caring et tout là. Juste rapidement les filles. C'est dans les conditions essentielles pour que la mathématique se fasse en classe selon le référentiel d'intervention en mathématiques. Il y a deux conditions, dont une, c'est qu'il faut qu'il ait un climat de classe justement avec ça, où est-ce que on a de la bienveillance, la collaboration, un sens critique et de la place pour la créativité. Donc c'est c'est directement en lien avec ce qui est demandé, ce qui est suggéré dans ce référentiel là comme tel.

answer your question Stephanie, I had norms for functioning in the class but I did not have norms for discussion. (Workshop 1, Group 2 Primaire, [01:27:51] – [01:28:42])	Mais effectivement, en tout cas, moi, pour répondre à ta question Stéphanie, j'avais des normes de fonctionner dans la classe mais j'avais pas des normes de discussion. (Workshop 1, Group 2 Primaire, [01:27:51] – [01:28:42])
Sophie: We had said to ourselves Stephanie in the end, it was a goal, for our next meeting, if everyone could perhaps give themselves a goal, that was the intention […] We were saying to ourselves that that could be an objective that we set for ourselves by the next meeting in order to be able to work a little to perhaps work on one aspect. It could be the norms. I remember, I had class norms, I've always had class norms but I didn't have dialogic norms. […] So it was a bit to propose this idea a little bit, it is not a formal obligation. We're not going to pick it up at the end / but / […]	**Sophie:** On s'était dit Stéphanie dans le fond, c'était un but, pour notre prochaine rencontre, si chacun pouvait se donner peut-être un but, c'était ça l'intention là […] On se disait que ça pourrait être un un objectif qu'on se donne d'ici la prochaine rencontre pour pouvoir un peu pour travailler peut-être un aspect. Ça peut être les normes. Moi je me rappelle, j'avais des normes en classe, j'ai toujours eu des normes de classe mais j'avais pas des normes sur le dialogue. […] Fait que c'était un peu à lancer un peu cette idée là, c'est pas un devoir formel, là. On va pas le ramasser à la fin /mais/ […]

Sophie: But I think you already know, when we decide to set things in motion let's say that by the end of the year you want more. But there is something like an appetizer that you will have to do with your students, it's like whatever we want to work on more, especially with with class norms that we have as much as that, dialogic norms, it's not something I really had. (Workshop 1, Group 3 Secondaire, [01:31:50] – [01:47:20])	**Sophie:** Mais je pense que déjà tu sais, quand on décide de mettre ça en branle là disons que d'ici la fin de l'année là tu veux davantage. Mais il y a comme une mise en bouche qui va falloir que tu fasses avec tes élèves, c'est comme de quoi que là, on veut travailler davantage, surtout en dans des des normes de classe qu'on a tant que ça, des normes de dialogue, c'est pas quelque chose que j'avais vraiment. (Workshop 1, Group 3 Secondaire, [01:31:50] – [01:47:20])

As observed throughout the open coding results, teacher support was an implicit though powerful condition motivating teachers' participation. The fact that teachers were supported by various resources outside of the parameters of the study (e.g., team teaching, student teachers, pedagogical consultant support) certainly played a non-negligible role in teachers' participation beyond what is shown in teachers' workshop discourse. Nonetheless, the presence and interventions of pedagogical consultants during the study also had an important impact on the progression of the discussions during the workshop and could be interpreted as helping teachers more efficiently reflect on the pertinence of the materials shown (i.e., teacher buy in), providing opportunities for teachers to reflect on their own practice, and even proposing manageable short-term goals.

Emerging Mechanisms: Empathy, Reflection and Deflection. In most cases, teachers' discourse can be characterized as shifting back and forth between being *empathetic* (toward teachers from the sample classroom vignettes) and *reflective* (thinking back on their own experiences), particularly when teachers were guided by the research-based activity and supported by a pedagogical consultant. However, as seen in the compelling narratives shown above, some teachers remained skeptical of pedagogical actions proposed if they had not already experienced the efficacy of the ideas shared. In these more difficult cases, teachers could be described as *deflective* in their approach to the activities, deflecting attention away from their own pedagogical actions to focus instead on the challenges experienced in their own classrooms. As seen in cases where teachers have students with significant behavioral issues or learning difficulties, the primary task of getting students to peacefully participate with one another, much less to challenge and build on one another's ideas, appeared to be an insurmountable mountain for some of the teachers.

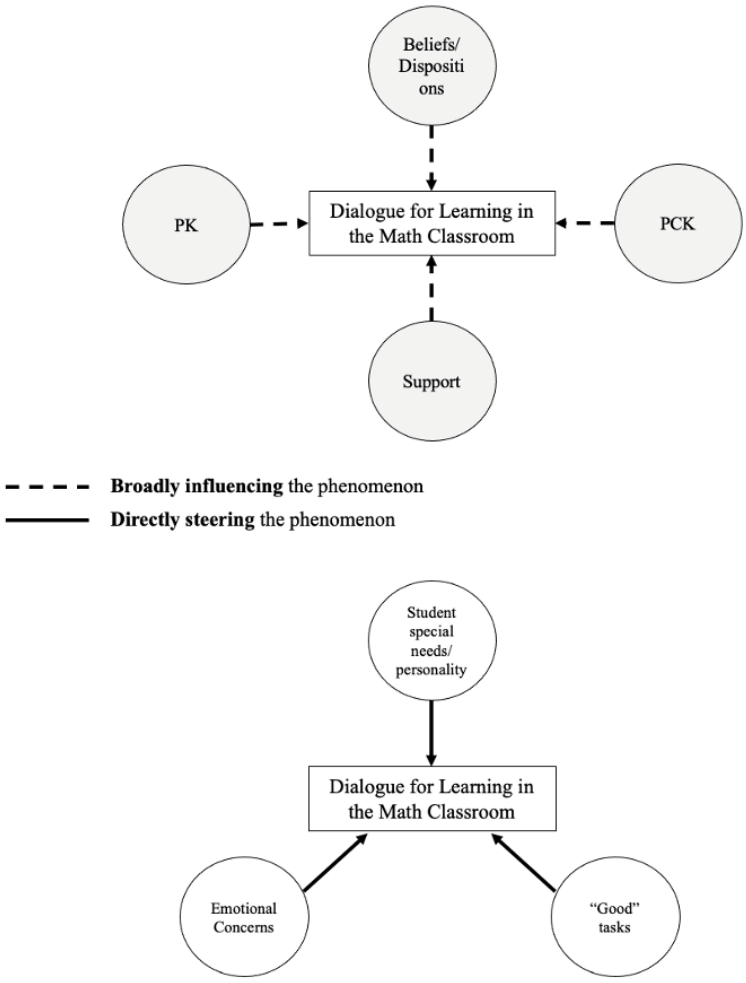
Axial Coding Continued—Preliminary Model of Factors Influencing the Emergence of Dialogue in the Mathematics Classroom

From a methodological point of view, teachers' Workshop 1 discourse made evident what appeared to be relatively stable categories paralleling those identified during teachers' initial interview responses—teaching-and-learning beliefs with regard to their role in encouraging classroom dialogue, classroom management knowledge, teacher support needs, and teachers' capacity to identify productive dialogue (see Figure 3). During the axial coding phase, these themes were categorized as *intervening conditions.* Intervening conditions juxtaposed a more fluid set of categories, labelled *factors*, which emerged when teachers were confronted with issues of dialogue discussed during the workshop activities. Furthermore, teachers'

perception of and how they attended to students' special needs and personalities, emotional concerns arising during small-group activities, as well as the complexity of framing a "good" math task (e.g., goal orientation, communication expectations) played an important role in the *strategies* that teachers described, including whether and how to project the use and value of research-based material within their own practice.

Figure 3

Phase 2—Preliminary Model of Intervening Conditions and Factors Influencing the Emergence of Dialogue in the Math Classroom



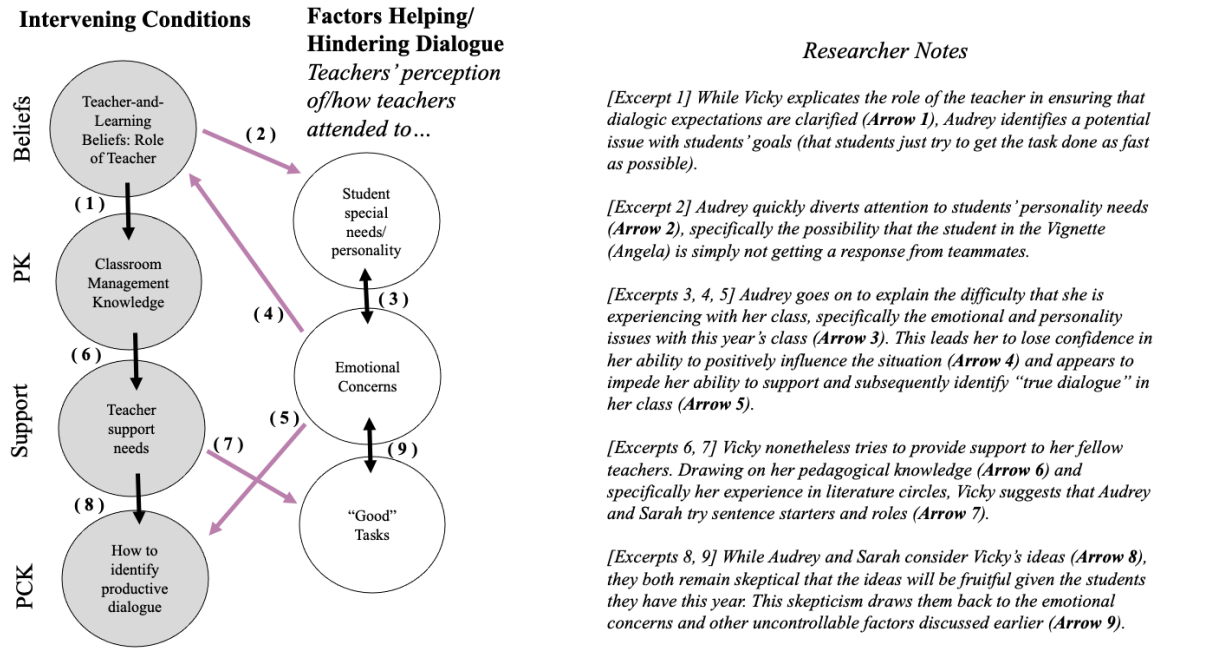
Selective Coding—Sketching Out a Model of the Interrelationship Between Emerging Factors

It became very clear during open and axial analyses that representing the emerging categories as stable entities would largely underestimate the fluid nature of their emergence. For this reason, a discursive complementary representation of the emerging categories was sketched out to aid further analyses (see Figure 4).

When analyzed across all three of the teacher workshop discourse, the factors helping/hindering dialogue in the classroom included recurrent challenges and opportunities described by participating teachers. These factors were directly linked to strategies (see Figure 5). However, these strategies remained intimately connected to the epistemic level, since the strategies described were often indissociable from teachers' knowledge and beliefs on what makes a group productive. Intervening conditions consisted of the underlying conditions influencing teachers' perception of factors, as interpreted through teachers' interview and workshop discourse. Arrows link categories that "influence" their object. For example, teaching-and-learning beliefs, specifically the role of the teacher, appeared to have influenced how teachers attended to classroom management. These beliefs also appeared to be intimately related to the manner in which and whether teachers attended to students' individual needs or the classroom learning community as a whole.

Figure 4

Phase 3—Explanatory Representation of the Emerging Model (Example from Workshop 1, Group 1 Elementary)



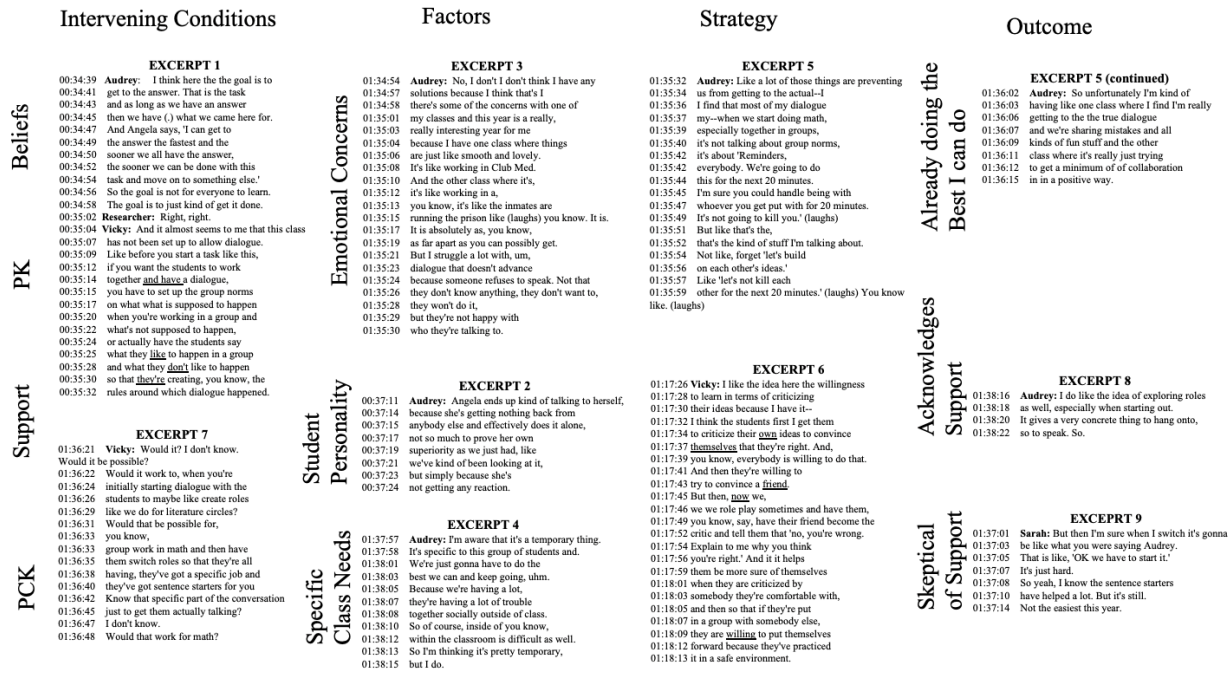
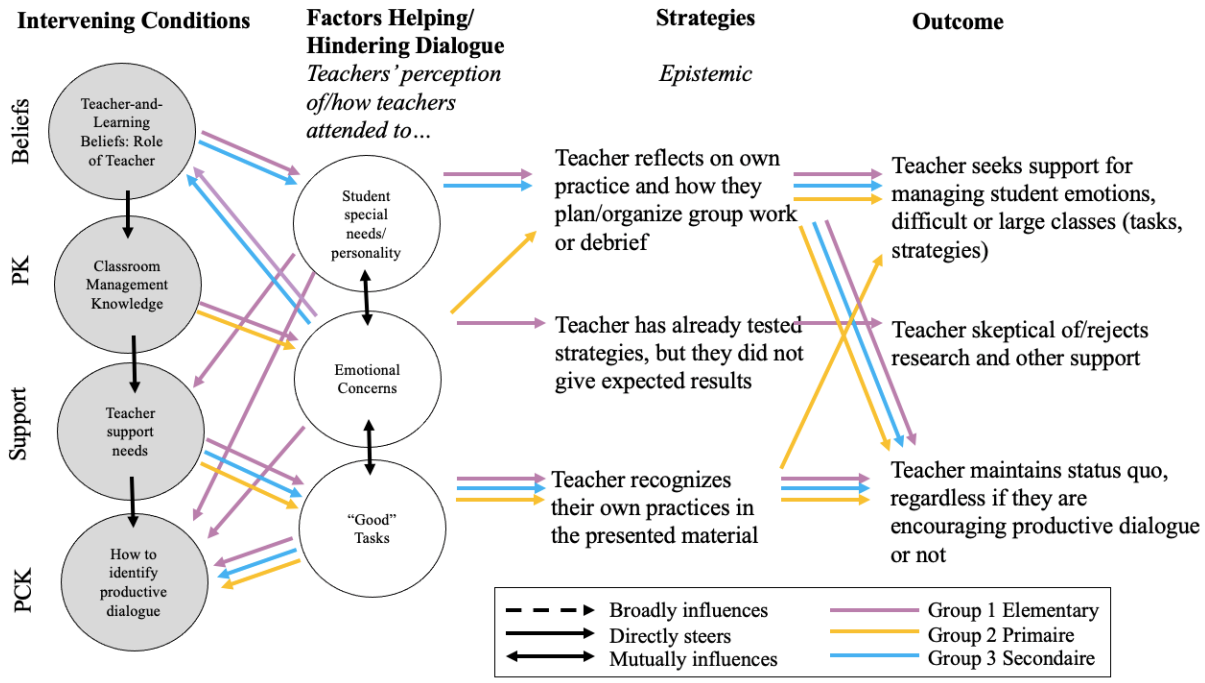


Figure 5

Phase 3—Model of Interrelationship Between Factors Influencing the Emergence of Dialogue in the Math Classroom (1st Iteration—Workshop 1)



In this sense, one could imagine a hierarchy, where, for example, teachers' request for support was influenced in part by their pedagogical knowledge (e.g., comfort managing small-group activities) and underlying that, whether small-group activities were conceptualized as groups of individual students or as a classroom broken up into smaller groups. Black unidirectional arrows represent this emerging hierarchy, though this hierarchical relationship would change later as new information emerged in teachers' workshop discourse. Bidirectional arrows reveal that categories were too closely related in teachers' discourse to piece apart or to create a hierarchy. For example, how and whether teachers attended to students' emotional concerns appeared to depend largely on the task and the instructions foregrounding students'

learning activity. Teachers rightly asked about the directions given to students before taking a position on students' behavior. As a facilitator, I also encouraged teachers to explore the task parameters as this would serve as a main idea later in workshop materials.

It was in constructing this discursive representation during the Selective Coding Phase that I managed to discover what could be described as a vicious cycle. In other words, the discussions revealed challenges from which teachers did not manage to break away during early conversations. In fact, by the time conversations steered toward more concrete practices and ideas based on methods for identifying and tracking productive dialogue, conversations reverted to instances of classroom interactions that reveal deeper challenges at the student level (students are difficult this year) and at the teacher level (teachers are already doing what they can but would welcome additional support).

Despite the challenges shared, most of the participating teachers showed interest nonetheless in learning about the next workshop themes (Group 1) and in participating in the classroom observations (Groups 2 and 3). This curiosity propelled the groups into the next phases of the workshops and data collection/analysis and raised the question on how the subsequent research activities (workshop content and discussions) might be better calibrated to ensure that teachers are getting support from the research project, particularly by getting opportunities to critically reflect with other teachers on their pedagogical practices and perspectives and to collectively explore avenues for meaningful change.

Theoretical Saturation—Testing the Model Against Teachers' Classroom Routines and Pedagogical Experimentation

As teachers went into their classrooms, for some to conduct classroom recordings and for others to continue business as usual, a small portion of teachers experimented with the ideas

presented in Workshop 1 and reported back to the group in Workshops 2 and 3. For contextual information, one secondary teacher withdrew from the study after the first workshop due to personal circumstances (i.e., pregnancy). Another secondary teacher withdrew from the study after the second workshop after she realized that she was not able to participate as much as she would have liked. A third secondary teacher could not attend the third workshop due to scheduling conflicts but participated in the remainder of the study (e.g., post-workshop interview). I noted in a memo that the teachers who chose to withdraw completely from the study were also those with the least number of years of teaching experience amongst all the participating teachers.

Workshop 2 The Difficulty of Creating a Dialogic Space. In deciding on a title for this sub-section, I chose "The Difficulty of Creating a Dialogic Space" not only to refer to teachers' experiences, but also to refer to my own experience facilitating the workshops. As the facilitator of the workshops, Workshop 2 was probably the most difficult to lead. As teachers came back with narratives of their classroom practice, the challenge was finding a way to acknowledge these different experiences while drawing from the research literature to augment their experiences with research-based knowledge. I hoped that these discussions would help teachers break away from the vicious cycle described earlier. This often took the form of affirming teachers' actions and explaining how the resources provided might help teachers to be self-reflective considering their classroom implementations. In all cases, teachers maintained a healthy skepticism when presented with the materials, asking clarification questions and engaging topics of discussion that were more meaningful to them.

In more closely analyzing teachers' classroom experiences since Workshop 1, teachers' classroom recordings and follow-up reports revealed different ways of implementing. In Group

1, the Grade 4 (Sarah) teacher tested out a new way of encouraging participation in whole-group settings, while the other two Grade 5/6 teachers (Vicky, Audrey) took an observer's role in their own classrooms, observing their students while their student teachers taught the classes. In Group 2, all three teachers decided to test out an activity to encourage their students to verbalize their thinking. While the Grade 5 teacher (Julie) proposed an open activity that she regularly uses in her class (an Open Middle), the two Grade 6 teachers (Mélissa, Cindy) reworked the activity shown during the first workshop (a secondary level activity on volume and area) and adapted it to their classrooms. Finally, in Group 3, most teachers maintained business as usual, while one Grade 7 teacher (Valérie), adapted the research-based checklist for productive dialogue moves so that observations could be used in tandem with mandated math assessments. The emerging discourse (i.e., concerns addressed by teachers, demonstrations of beliefs and knowledge, support provided or requested) confirmed the preliminary model categories while revealing other underlying nuances. These are described in detail in the following paragraphs.

Importantly, these opening exchanges confirmed the categories identified in preliminary analyses while also revealing different ways that teachers created personal sense of the materials. Teachers' discourse was again characterized by observations of students' emotional responses, nonverbal participation based on student personality/performance differences, and the pertinence of activities proposed.

Valérie: So I don't know Sophie if you'd noticed because we didn't have time to talk about it when we met again. There's one, on the contrary, for example, who had an anxiety attack during the activity.	**Valérie:** Donc c'est je sais pas Sophie si t'avais remarqué parce qu'on a pas eu le temps de s'en reparler quand on s'est revue. Il y en a une, au contraire, par exemple, qui a fait une crise d'anxiété

And then I met with her the next day because, you know during the activity, we were filming and everything I was like ‘okay, this is no time to deal with (haha) an anxiety attack.’ Then she didn't want to answer me. Then she said to me, ‘I'm afraid of being judged.’ Well I told her ‘no.’ From the start then you know, ‘I feel like they’re going to tell me that’ you know. So we had to come back to that with her ‘Well in your life, you're going to be faced with maybe teaming up with people you don't want to be with either.’ Whether it is our work at Cegep or at the university, sometimes we’re going to meet up with certain people with whom we had little or no affinity, but it was like that. So I saw the, I saw the opposite side during the same period. The anxiety attack, then the other student who was super delighted to to hear the comments of other students with whom she did not

pendant l'activité. Et puis je l'ai rencontré le lendemain parce que, tu sais pendant l'activité, on filmait et tout j'étais comme 'okay, c'est pas le temps de gérer (haha) une crise d'anxiété.' Puis elle voulait pas me répondre. Puis elle me dit, 'j'ai peur d'être jugé.' Ben je lui ai dit 'non.' Depuis le début puis tu sais, 'j'ai l'impression qu'ils vont me dire que' tu sais. Fait qu'il a fallu revenir avec elle par rapport à ça que 'Ben dans ta vie, tu vas être confrontée peut-être placée en équipe avec des gens avec qui tu veux pas être là aussi.' Que ce soit nos travaux du Cegep ou de l'université, des fois on va se ramasser avec certaines personnes avec qui on avait peu ou pas d'affinité là, mais c'était comme ça là. Fait que j'ai vu les, j'ai j'ai vu l'inverse pendant la même période. La crise d'anxiété, puis l'autre élève qui était super enchantée de d'entendre les commentaires d'autres élèves avec qui elle travaillait pas habituellement.

usually work. (Workshop 2, Group 3 Secondaire, [00:11:21] – [00:12:20])	(Workshop 2, Group 3 Secondaire, [00:11:21] – [00:12:20])
Cindy: Well, I have a student and you are going to see if, when you go to listen to him ((*in the recording*)), he is more, for me, I found him to be a spectator, but as soon as he starts speaking, it was relevant. But the whole way through, there is one who is much more of a spectator than active. There is one who took the leadership role, to organize everyone. But the other student, who is weaker or who has more difficulties, still asked questions and then the explanations were good, so there was really an exchange. (Workshop 2, Group 2 Primaire, [00:04:11] – [00:04:38])	**Cindy:** Ben, j'ai un élève et vous allez voir si, quand vous allez l'écouter ((*dans l'enregistrement*)), il est plus moi, je trouvais comme spectateur, mais au moment où il parlait, c'était pertinent. Mais tout le long, il y en a un qui est beaucoup plus spectateur que actif là. Y'en a un qui a comme pris le leadership là, d'organiser tout le monde. Mais l'autre élève, qui est plus faible ou qui a plus de difficultés, posait quand même des questions puis les explications étaient bonnes, donc il y avait vraiment un échange. (Workshop 2, Group 2 Primaire, [00:04:11] – [00:04:38])

However, this time, teachers' descriptions were mediated by concrete instances of teacher actions and the consequence of those actions (or non-actions) on students' participation. These accounts revealed both neutral and positive outcomes, ranging from acceptance of the status quo (i.e., no significant change in practice) to significant pedagogical noticing episodes. For example, one elementary teacher in Group 1 used the opportunity she had with her student teacher to re-

watch her class as if from an outside perspective. This outsider perspective revealed a surprising realization that her own communicational style may inadvertently foreclose student dialogue.

> **Vicky:** I have a student teacher as well, so I haven't. I've been more observing then than actual teaching, and it's really been interesting because, um, with me when we're doing math or they're talking and I'm walking around and asking questions, the students sort of clam up and are not willing to express themselves freely. […] So I'm realizing that maybe I need to be a little bit more uncertain when I teach if I'm going to want them to verbalize their opinions and and not be so sure of myself in front of them. (ha)
>
> (Workshop 2, Group 1 Elementary, [00:12:06] – [00:12:53])

Another elementary teacher, Mélissa (Group 2), admitted that she might have inadvertently foreclosed the dialogue during the follow-up discussion by speeding through the debrief to get everything on camera before the end of class. Getting caught by the bell was an issue that one of the secondary teachers mentioned as well in the pre-workshop interviews.

Ultimately, teachers' perception of their own and their students' sensemaking processes was not taken for granted. Valérie (Group 3) described the difficulties experienced while encouraging students' verbal participation, particularly through the *Building* and *Challenging* dialogic moves discussed during Workshop 1. She describes the emotional hurdles for students who are not accustomed to working with classmates with whom they are not close friends. Yet, she remained very positive that these instances, though difficult in the moment, would bring about significant learning moments for students' social, emotional, and communicational development. In the end, Valérie connected these social moments with the task of collectively building a classroom culture of dialogue.

Valérie: But the students, I don't know if you wanted us to talk about the follow-up, it's that sometimes they're afraid to challenge (ha). […] How could I say this, we are creating together, everyone, we are learning and not the class or you the sage on the stage, then the students are passive, listening you know. So I think it's a classroom culture that we are also developing and then working with them at the same time. (Workshop 2, Group 3 Secondaire, [00:08:10] – [00:08:44])	**Valérie:** Mais les élèves, je sais pas si tu voulais qu'on parle d'un retour là, c'est qu'ils ont peur des fois challenger là (ha). […] comment je pourrais dire, on est en train de créer en ensemble, tout le monde, on est en train d'apprendre et non c'est la classe ou toi le maître devant, puis les élèves sont passifs, qui écoutent là tu sais. Fait que je pense que c'est une culture de la classe qu'on est en train aussi de de développer puis de travailler avec eux en même temps. (Workshop 2, Group 3 Secondaire, [00:08:10] – [00:08:44])

While teachers experienced different sensemaking processes while implementing dialogue-intensive approaches in their individual classes, the workshop groups also had different collective meaning-making experiences. Teacher group discourse revealed different points of entry in relation to the intervening conditions influencing their decision-making processes, and specifically the strategies used to encourage more dialogue in their classrooms. Group 1's observations were largely mediated by pre-existing support mechanisms and the conceptual knowledge presented in the first workshop. For Vicky and Audrey, an "outside" perspective was permitted thanks to the presence of a student teacher. For Grade 4 teacher, Sarah, simply discussing the theoretical positioning of the workshops (i.e., brief overview of self-regulatory concepts) provided her with a possible lead as to why her students may be having difficulties

participating in classroom dialogue (e.g., lack of emotion regulation strategies, lacking self-confidence). These support mechanisms (student teachers, concepts) led teachers to question their pedagogical knowledge, specifically regarding the factors hindering students' reflection.

> **Vicky:** It's kind of like it's it's, does one do the other? Like are they are they not doing as well 'cause they're not self-reflecting or they do they, do they not self-reflect because they're not as confident? It's like which one? (laughs)
>
> (Workshop 2, Group 1 Elementary, [01:06:38] – [01:08:31])

Different than Group 1 discussions, Group 2 discussions were more closely linked to teachers' developing pedagogical knowledge, specifically related to orchestrating norms for student dialogue. The pedagogical consultant (Patricia) played a crucial role during these initial talks given her presence in participating teachers' classrooms. For example, the consultant offered to handle the recording components of the study, demonstrated how teachers can model norms for dialogue, and gave live feedback to teachers during classroom experimentation. Surprisingly, classroom recordings revealed that Patricia utilized a different set of norms for dialogue than those provided in the workshops. I initially presented Roger Sutcliffe's 4 C's which are based on Matthew Lipman's work on philosophy for children. Additionally, the 4C's had been transformed into an activity for establishing "ground rules" (Phillipson & Wegerif, 2019, p. 39), which I would later use for a professional development activity with the teachers in Workshop 2 (see Appendix J). For Workshop 1, I presented the 4 C's in English with translations given in French (caring/*bienveillance*, collaboration/*collaboration*, criticality/*sens critique*, creativity/*créativité*). Instead of building on the 4 C's, Patricia presented teachers with a different set of C's. Entitled "The 5 C's of maths": curiosity, creativity, courage, collaboration, convince (*Les 5C des maths: curiosité, créativité, courage, collaboration, convaincre*), these new

classroom rules, as Patricia would describe to me later during our final debrief meeting, originated in a francophone/Quebecois context. They were created by educational "influencer" (Patricia's words) Jocelyn Dagenais (https://lapageadage.com/les-5c-des-maths/), whose work draws on both Jo Boaler's work (e.g., from her book *Mathematical Mindsets*) as well as Catherine Michaud's work, another educational "influencer" (again, the pedagogical consultants' words). Artifacts from teachers' classrooms show the pedagogical consultant demonstrating these norms for dialogue with Mélissa's students. Mélissa and Cindy subsequently reinforced these norms during the next discussion-centred tasks in their classrooms. In contrast, Julie arranged her own norm activity using her knowledge of "math talk" and the tips provided in the workshop materials.

When the Group 2 teachers met to discuss their first enactments, they addressed different levels of pedagogical knowledge, ranging from lower-level concerns, such as managing the physical and temporal planning of small-group activities (e.g., how to seat students at the table), to higher-level concerns, such as attending to students' metacognitive capacities. Again, the pedagogical consultant's interventions were crucial during these discussions, supporting the content material by explaining the rationale behind similar principles promoted in earlier versions of the provincial math program. In this sense, even the pedagogical consultant's tacit knowledge is expressly mentioned for the benefit of the teachers present.

Patricia: By the way, if I can add to that, several years ago, we were extremely strong with reflection on making students do a lot of self-evaluation where we were positioning them. I see Cindy nodding	**Patricia:** Mais d'ailleurs, si je peux faire du pouce là-dessus, il y a plusieurs années, on était extrêmement fort sur la réflexion où est-ce qu'on faisait faire beaucoup d'autoévaluation aux élèves où est-ce

(her head) it's like we've abandoned all that! That's when we had the pedagogical renewal, we went back to the old research and everything on self-regulation, and the idea of focusing the student who reflects on the process. So more and more, we come back to the idea of we are going to organize tasks or we are going to organize a time of self-reflection at the end of the meeting, something that we did before but that we have abandoned. (Workshop 2, Group 2 Primaire, 01:17:54] – [01:18:34])	qu'on les positionnait. Je vois Cindy là qui fait signe de (la tête) qu'on a comme délaissée ça ! C'est quand on avait mis le le renouveau pédagogique, puis on revient avec les recherches datées et tout sur l'autorégulation, puis l'idée de centrer l'élève qui réfléchisse à son processus. Alors de plus en plus, on revient à l'idée de on va organiser des tâches ou on va organiser un temps de d'auto-réflexion à la fin de la rencontre, chose qu'on faisait avant mais qu'on a comme délaissée. (Workshop 2, Group 2 Primaire, 01:17:54] – [01:18:34])

In Group 3, exchanges primarily focused on ways to connect research goals with math assessment goals. Valérie had found it difficult before the research project to simultaneously observe and take notes on students' participation in groups. Yet, she found that the research-based checklists focusing on *Building* and *Challenging* (*construire, ou bâtir, et se challenger, ou se remettre en question*) dialogic moves that she coined in French "Challenge 1 and Challenge 2" (*le défi 1 et le défi 2*) aided her practice in identifying and tracking students' productive contributions in line with research and math program guidelines.

Researcher: Valérie, I thought of you with the observation checklists. You said	**Researcher:** Valérie, j'ai pensé à toi avec les grilles d'observation. Tu as dit tout à

earlier--Was the observation checklist that you used with challenge one and challenge task two, was that something you were already used to? to doing?	l'heure-- Est-ce que la grille d'observation que t'as utilisé avec le défi un et défi défi deux, est-ce que c'était quelque chose que t'avais déjà l'habitude de faire ?
Valérie: No, actually, I was, I was inspired by the documents that you had provided to build the checklist which is super simple. But since then I'd say that before the holidays or after the holidays, I had discussed with Sophie, precisely about the famous triangulation of learning and then to try to take notes on observations that I make in class. It's In Progress, it's not easy to be in the heat of the moment, then to take notes at the same time. So I was already doing it a little bit but not with the checkli-- well you know not with the specific challenges like that. It was more of a table where I observe things. (Workshop 2, Group 3 Secondaire, [01:08:56] – [01:09:46])	**Valérie:** Non mais en fait, je m'étais, je me suis inspirée des documents que tu l'avais fournis là pour le pour construire la grille qui est super simple. Mais depuis je dirais qu'avant les les fêtes ou au retour des fêtes, j'avais discuté avec Sophie, justement, la fameuse triangulation des apprentissages puis de d'essayer de prendre en note des observations que je fais en classe. C'est In Progress, c'est pas évident d'être dans le feu de l'action, puis ça noter des choses en même temps. Fait que je le faisais déjà un petit peu mais pas avec des obser--bah tu sais pas avec des défis précis comme là. C'était plus une grille où j'observe des choses. (Workshop 2, Group 3 Secondaire, [01:08:56] – [01:09:46])

Here, similar to Group 2, the contributions made by the pedagogical consultant, Sophie, played a major role in further justifying the use of resource-based resources like Valérie

described. Sophie emphasizes how teachers can align the research-based checklists with the mandated assessment material, saying, “once you have these traces (of dialogue from the checklists) it's not just traces for your dialogue, it's also mathematical competencies that you assess at the end of the year, because why start working double.” Additionally, Valérie’s adaptation of the checklist appears to have played an important role in whether and how other participating teachers found value in the research-based resources. In the workshop dialogue, Céline shows genuine interest in Valérie’s idea and asks whether she would mind sharing the Smart Board version of her activity.

Recognizing that teachers may become discouraged or lose motivation to try out these new strategies for identifying and assessing productive dialogue in the math classroom, Sophie further connects the research-based activities with provincially valued activities (“co-evaluation”) and encourages teachers to persevere, especially since the results are not always immediate.

Sophie: […] at the national level the Récit we worked on types of tasks for evaluating differently and we decided that assessments were always assessments in the format of a co-evaluation because we wanted to allow time for the student to self-assess for each of the tasks before the teacher assesses. […] Then there are the teachers, who often are going to give up because it was difficult. […] But there’s a	**Sophie:** […] au niveau national le Récit on a travaillé sur des des types de tâches pour évaluer autrement et on a, on a décidé que les grilles étaient toujours des grilles sous le format de la co-évaluation parce qu'on voulait permettre un temps à l'élève de s'auto-évaluer pour chacune des tâches avant que l'enseignant évalue. […] Puis il y a des enseignants, souvent vont baisser les bras parce que ça a été difficile.

teacher who they told us persevered. Then she continued to do it, explaining a little about her intention in doing it. Then finally they slowly began to have an effect. (Workshop 2, Group 3 Secondaire, [01:24:02] – [01:24:48])	[…] Mais il y a une enseignante qui nous nommait que elle a été persévérante. Puis elle a continué à le faire en expliquant un peu le l'intention de le faire. Puis là ils commencent tranquillement avoir de l'effet. (Workshop 2, Group 3 Secondaire, [01:24:02] – [01:24:48])

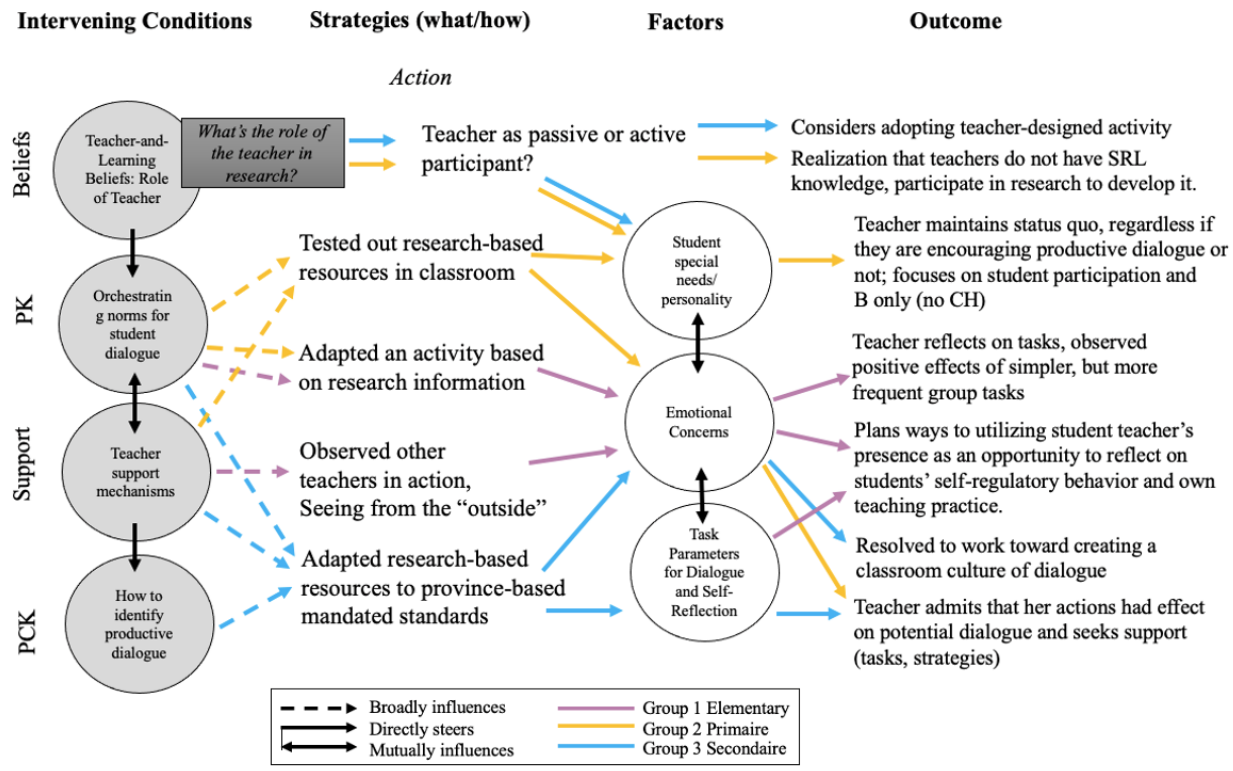
As these conversations unfolded, it became evident that the two categories "support" and "pedagogical knowledge" originally depicted in the model as a unidirectional relationship (from pedagogical knowledge to support) appeared to be mutually influencing one another. Consequently, a bidirectional arrow replaced the unidirectional arrow (see Figure 6). After the second iteration of model testing, all categories were maintained and further specified (e.g., "classroom management knowledge" became "orchestrating norms for student dialogue"). Strategies and factors also switched places. This switch was made to stay close to the data, in the sense that teachers recounted their actions before discussing their own observations. Teachers' observations of factors helping or hindering dialogue echoed those described in the first workshop. Most of the teacher discourse evidenced some type of change, whether in practice, perspective, or in teachers' discourse about classroom dialogue. Examples of these discursive changes, but also unexpected lack of change, are elaborated in the next paragraphs.

During these discussions, I observed multiple instances of teachers and consultants willingly using the research-based terms associated with strategies for identifying productive dialogue (Participation/*participation active*, Building/*construire*, Challenging/*questionner*). While it was hoped that teachers would use these terms in their classroom practice, I did not

know in advance how these terms would be taken up in teachers' workshop discourse. Moreover, my focus as the workshop facilitator was to ensure that the concepts underpinning participation in dialogue was at the centre of our discussions. As I facilitated the workshops and as I conducted the line-by-line coding, the emergence of these moves in teacher discourse could not be ignored. In Workshop 1 and 2 discussions, teachers focused on examples of general participation or students building on one another's ideas and less on challenging one another.

Figure 6

Phase 4—Model of Interrelationship Between Factors Influencing the Emergence of Dialogue in the Math Classroom (2nd Iteration—Workshop 2)



Note. B=Building (students build on one another's ideas), CH=Challenging (students challenge and question one another's ideas and seek mathematics reasons for accepting different views)

Surprisingly, some of the teachers even went back to the nonverbal accounts of productive dialogue affirmed during pre-workshop interviews. One teacher's account of a student's contributions, particularly a second language learner, provides a significant example of how teachers gauge student participation by observing what happens in students' "eyes". This observation added a significant point of tension in my model, specifically that, even when teachers are encouraged to consider research-based evidence of the importance of highlighting verbal interactions, the nonverbal still holds significant value for teachers' informal assessment of students' understanding. For instance, Patricia, the elementary consultant, was admiring the student checklist with the three criteria (active participation, building, challenging), when she interrupts her commentary to open up the conversation to a fellow teacher, Cindy. In this moment, Patricia invites Cindy to talk about how she evaluated quiet students' participation ("low participation score") with other nonverbal signs.

Patricia: […] you said that there was one of your students, that maybe in participation, you wouldn't put [him] very high, except that it's not because he wasn't speaking that he wasn't active either.	**Patricia:** […] tu disais qu'il y avait un de tes élèves, que peut-être en participation, tu mettrais pas très élevé, sauf que c'est pas parce qu'il parlait pas qu'il n'était pas actif non plus.
Cindy: No that's it. In his eyes I could see that something was happening at certain times […] he didn't have the right words, you know, he's missing, he's a student who doesn't speak French at home so. The, the vocabulary, it wasn't there […]	**Cindy:** Non c'est ça. Dans ses yeux je voyais qu'il se passait quelque chose à certains moments […] là il y avait pas les bons mots, tu sais, il manque, c'est un élève que, parle pas français à la maison donc. Le, le vocabulaire, il était pas là

then you know, I saw it, he was looking at the teams around him. Then there at one point he sort of realized that it would have been more efficient the other way. You know for sure that he, in you know in *Building* you know, on ideas, he was in the *Building* because he was looking in his head how they could be more efficient (Workshop 2, Group 2 Primaire, [00:58:14] – [00:59:02])	[…] puis tu sais, je le voyais, regardais les équipes autour. Puis là à un moment donné il a comme réalisé que ça aurait été plus efficace, de l'autre façon. Tu sais c'est sûr que lui, dans tu sais dans rajouter tu sais, aux idées, il était dans la *Construction* parce qu'il cherchait dans sa tête comment on peut être plus efficace (Workshop 2, Group 2 Primaire, [00:58:14] – [00:59:02])

Audrey (Group 1) openly acknowledges that teachers do not always use the types of explicit verbal indications encouraged in the research study materials:

> **Audrey:** I think that the merit to having some of these observation, either templates or or cycles to look at, is that it allows us to look at the students, for myself even, sometimes if there are students that are easy to forget about, either because they're always on task, or because they seem to, they don't verbally participate, and I think this is kind of gives you incentives to watch them in in other to try to sense their or to gauge their understanding in different ways (Workshop 2, Group 1 Elementary, [01:34:11] – [01:34:35])

This tension was further raised during one of the interactive activities planned as part of the workshops (Workshop 2 for Groups 2 and 3, Workshop 3 for Group 1). An interactive online activity on dialogic group norms revealed the benefit of not only working with teachers on their knowledge of productive dialogue and how to identify it, but also on how to continually sustain

it. In this activity, I asked teachers to share how they can promote the 4 C's of a dialogic classroom. I chose an online application that allowed teachers to create electronic post-it notes (here I use Padlet) (see example in Appendix J). On an electronic post-it, teachers identified behaviors or ideas that came to mind in response to each of the four C's. I then asked teachers to modify the post-its that they just created by adding an additional line specifying the types of words, expressions, or actions that they would like to hear or see and that would signal to them that they or their students are effectively working toward the target behaviors or ideas. In all three groups, criticality/*le sens critique* received the least number of post-its (only 2 post-its compared to 3-5 post-its in other dialogic categories). With this in mind, one could make a parallel with teachers' own descriptions of practice, that is, prioritizing general participation over challenging. Also, this activity challenged my own assumptions given that most of the teachers (Groups 2 and 3) did not participate through talking during this activity, focusing instead on adding post-its. To echo the point made previously about students' nonverbal participation, it was interesting to see how teachers who had not been particularly vocal up to this point actively joined in this activity. Thus, I was also put in the shoes of teachers encouraging different ways of participating and acknowledging the need to consider other forms of productive dialogue beyond discussion-based activities.

Another revelatory nuance concerned teachers' positioning vis-à-vis research. Teachers' discourse revealed different expectations on the role of the teacher in research. Teachers' beliefs about the role of the teacher became more evident when teachers voiced their positions going into a research project like this one. For example, elementary teachers in Group 1 acknowledged their own difficulties being self-regulated, much less conducting pedagogical practices that help students become more self-regulated.

Cindy: It's kind of like what we're doing now, you know. You know if we decide to participate in research, it is because we want to self-regulate a little bit in/	**Cindy:** C'est un peu ce qu'on fait tu sais comme présentement. Tu sais si on décide de participer à la recherche, c'est qu'on veut un peu s'autoréguler dans/
Patricia: Exactly!	**Patricia:** Exactement !
Julie: Absolutely.	**Julie:** Tout à fait.
Cindy: We don't pretend to be perfect and to know everything. I find it to be a nice parallel.	**Cindy:** Là on a pas la prétention d'être parfaite et de tout connaître là. Je trouve que c'est un beau parallèle.
Patricia: Yes indeed.	**Patricia:** Oui effectivement.
(Workshop 2, Group 2 Primaire, [01:19:01] - [01:19:22])	(Workshop 2, Group 2 Primaire, [01:19:01] - [01:19:22])

In contrast, one of the secondary teachers in Group 3 voiced her confusion about the expectations of the research project, perhaps not immediately recognizing the possibility of transforming the workshops into a dialogue about pedagogy.

Céline: Well with us the difference, it was me who had misunderstood, but the difference with Valérie, you know, I listened to her talk, I found her, I found it really cool what she did, what she did had given, her expectations, let's say to discuss (1.0) towards the students, which we didn't do. We talked about the research	**Céline:** Bah nous la différence, c'était moi qui avais comme mal compris, mais la différence avec Valérie, tu sais, j'ai écouté parler, je la trouvais, je trouvais ça vraiment cool ce qu'elle a fait, ce qu'elle avait donné, ses attentes, mettons de discussion (1.0) envers les élèves, ce que nous on n'a pas fait là. On a parlé du

project and all that. What it consisted of. Then you know like me, I thought it was more about our own interventions. […] In any case, it's good that I heard what Valérie did because it makes me realize that maybe yes for the second part, you know, I, I, I. Maybe we should name clear expectations or you know where what is expected of them, then all that. It might also be more effective as a dialogue. (Workshop 2, Group 3 Secondaire, [00:22:52] – [00:24:04])	projet de recherche puis ça. En quoi ça consistait. Puis tu sais comme moi, je pensais que c'était plus selon nos interventions à nous. […] En tous cas c'est bien que j'aie entendu ce que Valérie elle a fait là parce que ça me fait réaliser que peut-être que oui pour la deuxième partie, tu sais, je, je, je. Peut-être qu'il faudrait nommer des attentes claires ou tu sais vers où ce qu'on s'attend d'eux, puis tout ça. Ça serait peut-être plus efficace aussi comme dialogue là. (Workshop 2, Group 3 Secondaire, [00:22:52] – [00:24:04])

As seen in this quote, this confusion turned to appreciation when she realized that one of her fellow teacher's ways of orchestrating group norms might be relevant in her own classroom. Thus, analysing the way teachers observed and implemented dialogue-based activities in their own classrooms provided a window not only into teachers' tacit sensemaking activity, but also into their meaning making activity as teachers' tacit assumptions of their role as a teacher emerged during the pedagogical workshop conversations.

Workshop 3—Dialogic Principles as a Mirror Mechanism. At the outset of Workshop 3, there was a marked shift in teachers' discourse. As described earlier, Group 3 was two members short (one for withdrawal, another for scheduling conflicts). Thus, all three groups ended with three teachers in each group. Teachers were much more comfortable talking with one

another evidenced by more teacher participation. For example, one secondary teacher who had not participated in the discussions in the first and second workshops joined in the final discussion and talked at length about her journey over the last two recordings. The mood of the final workshop was also congratulatory, with the consultants and me commending teachers for making it through to the final workshop despite the constraints related to the pandemic and the end-of-the-year rush.

One of the first topics that teachers brought up in all three groups concerned whether teachers witnessed any change in their students' dialogue compared to the first recordings or observations. Whereas one might suspect that teachers would gravitate toward overly positive comments (social desirability bias), on the contrary, teachers recounted different lived experiences. In fact, not only were teachers comfortable sharing different classroom experiences, but their discourse about their classrooms changed. Whereas teachers' initial descriptions of their own classroom observations had been characterized by general participation and *Building* episodes (Workshop 2), by Workshop 3 teachers were more focused on whether their students were participating in C*hallenging*, questioning, and argumentation.

> **Vicky:** Yeah, and actually I sort of I don't know if I took it the right way, but they were controlling the challenge in terms of the task. But then I'm actually getting the students to feel more comfortable, challenging each other's ideas.
>
> **Researcher:** Excellent, excellent. I'm gonna I'm just putting it in the chat just to, um. ((*writes in chat menu*)) Put it there so students can control challenge great. And you said that students can control one another's challenges, right?
>
> **Vicky:** Right, or being willing to actually accept challenges and to challenge each other.

Researcher: Excellent.

Vicky: I actually had one student actually walk up to the front and challenged the my student teacher today. (laughs) (Workshop 3, Group 1 Elementary, [00:08:35] – [00:09:14])

Valérie: I have the impression that it was perhaps a little more difficult this time because they think it is less about explaining, challenging than during the first activity. Maybe this is because the activity is a little different as well. It was the first time, you know we worked on a vertical surface. So that's why I told Sophie for tomorrow in the end, I want to launch the same challenge again. I don't want to change. So again it's going to be about being able to always explain how they did it. Then uh, you know to be comfortable, to come and challenge others and then say, 'Hey, I'm not sure that's it,' so in that sense we're going to continue working on it. (Workshop 3, Group 3 Secondaire, [00:03:48] – [00:04:26])

Valérie: J'ai l'impression que c'était peut-être un petit peu plus bah difficile parce qu'ils pensent c'est moins cette fois-ci à expliquer, à challenger que lors de la première activité. Peut-être là c'est parce que c'est un peu différent aussi comme activité. C'était la première fois, tu sais qu'on venait travailler sur une surface verticale. Fait que c'est pour ça que j'ai dit à Sophie pour demain dans le fond, je veux comme lancer encore le même défi. Je veux pas comme changer. Fait que ça va être encore d'être capable de toujours expliquer comment ils ont fait. Puis euh, tu sais d'être à l'aise, à venir challenger les autres puis dire, 'Hey moi je suis pas sûr que c'est ça,' puis dans ce sens là là qu'on va continuer à travailler. (Workshop 3,

> Group 3 Secondaire, [00:03:48] – [00:04:26])

It is worth noting here that Valérie expresses observing less C*hallenging* from students during the second recorded activity compared to the first recorded activity. However, when I observed her focal students' talk during the activities that she mentioned, there were marked improvements in the quality of students' interactions in the second recording. Students' interactions in the second recorded activity were marked by questioning and elaboration, contrary to the first recorded activity during which students' interactions seemed a little bit forced. What's more, second activity was marked by curiosity while students tried to genuinely understand the reasoning behind their teammates' strategies. However, it is highly likely that Valérie was expressing her thoughts on behalf of the whole class, thus projecting her frame of reference beyond what was observed in one small group's brief recording.

What was even more compelling was how teachers' observations, whether positive or less than ideal, were intimately connected to teachers' knowledge and beliefs about the types of socio-cognitive prerequisites necessary for *Challenging* discourse to occur. For example, primary teachers' pedagogical commentary centred on open tasks as ability equalizers, serving to put students on an equal playing field, so to speak, so that argumentation could occur.

> **Audrey:** /which was quite an interesting thing, and even the kids who were way off acknowledged that, they said, 'well, I'm gonna share my answer, but I'm pretty sure it's wrong because it just seems way too big.' So it was an interesting way of hearing them negotiate that and it really I think, was in that case, thanks to the fact that there were no numbers. So my students, who are more prone to calculate right away, actually couldn't

because they didn't have the information to calculate. They had to think logically about the problem I had so.

Vicky: Is it possible Audrey that the ones that aren't usually talkative were more inclined to talk because they're usually afraid of numbers, but they didn't have to be this time (laughs)

Audrey: Probably probably. And the kids who usually have the absolute answer there was no way for them to have the absolute answer, so there was no way to convince someone in that absolute way of like I did a calculation, and this is it. They could only just offer a conjecture like everybody else. (Workshop 3, Group 1 Elementary, [00:22:10] – [00:23:01])

Julie: I remember it because I saw it in the two groups of students, in both sides there. The strong ones stick to one way, one vision, while the weak ones are so used to looking for 'Ahhh' that they find lots and lots and lots of ways to do it. Then they really explain in a way, it’s as if they’re used to being asked, by the teacher, by everyone, how you did it to the others that, well, it's them who bring the strong ones forward more than the other strong ones because very often they	**Julie:** Là je m'en rappelle parce que je l'ai vu dans les deux groupes d'élèves, dans les des deux côtés là. Les forts s'en tiennent à une façon, une vision, tandis que les faibles sont tellement habitués de chercher à 'Ahhh' que eux autres ils trouvent comme plein, plein, plein de façons de faire. Puis ils les expliquent vraiment de façon, on dirait qu'ils sont habitués de se faire demander par leur tour par le prof, par tout le monde, comment t'as fait aux autres que, ben, c'est eux qui

(the stronger students) say, 'no, it can't be! It can’t be! ' Then the weak ones go 'no, look' and they’re right. So the my weak ones, their marks have been going up since this time it's completely crazy […]

Cindy: You see me my strong ones they are like collapsing because it looks like it’s confronting them with something that they’re not used to. They are like taken aback because there is more than one answer, then for them, it’s like inconceivable. Like calculate a percentage, just one way of doing it, I said, 'no, there isn't just one (way).’ So, ‘Ah? No? Well, I didn't do it like you.’ You know, ‘calculate a discount’ for example. They do it based on the unit price but you could do it based on the total, all that. ‘I didn’t go through the same path as you. So try to find.’ So ‘Well no, there is no other way there.’ So it creates a kind of discomfort, an uncertainty. Which is why it’s interesting.

amènent les forts plus loin que les forts parce que bien souvent, ils font, 'non, ça se peut pas ! Ça se peut pas !' Puis, les faibles font 'non ben regarde' puis ils ont raison. Fait que les mes faibles, ça monte là les notes depuis ce temps-là c'est complètement fou […]

Cindy: Tu vois moi mes forts ils sont comme dégringolade parce qu'on dirait que ça les confronte à quelque chose qui sont pas habitués. Là, ils sont comme des emparés parce qu'il y a plus qu'une réponse, puis pour eux, là comme inconcevable. Comme calcul en pourcentage, juste une façon de faire, j'ai dit, 'non, il n'y en a pas juste une.' Là, 'Ah ? Non ? Ben moi j'ai pas fait comme vous.' Tu sais, 'calculez par exemple un rabais’. Ils font sur le prix unitaire mais il pourrait le faire sur le total, tout ça. ‘Moi je suis pas passé par le même chemin que vous. Essayez donc trouver.' Là 'Ben non, il n'y a pas d'autres façons là.' Donc ça

Julie: A cognitive conflict.

Researcher: Well done Julie! (laughs)

Julie: As for me, I tell them that their brain explodes during these times, your brain was exploding then. So 'ohh yeah yeah!' Meh! (laughs) But it's fun to have that. Then I find that what it does is that the weaker children who are used to being told that, (they're) not as good, that their results aren't as good, they see that no, no, it's them, they're the ones who pull everyone else up, it feels good, for their self-esteem on this side.

(Workshop 3, Group 2 Primaire, [00:06:33] – [00:08:34])

crée comme un un inconfort, une incertitude. Qu'est pour ça que c'est intéressant.

Julie: Un conflit cognitif.

Researcher: Bravo Julie ! (laughs)

Julie: Moi je leur dis que leur cerveau explose dans ce temps-là, le cerveau était en train de t'exploser là. Alors 'ohh ouais ouais !' Meh ! (laughs) Mais c'est le fun d'avoir ça. Puis je trouve que les ce que ça fait, c'est que les enfants plus faibles qui sont habitués de se faire dire que, moins bons, des moins bons résultats, là, ils voient que non, non, c'est, c'est eux qui tirent tout le monde, ça fait du bien, l'estime de soi aussi à côté là.

(Workshop 3, Group 2 Primaire, [00:06:33] – [00:08:34])

In a similar vein, secondary teachers discussed using dialogic practices to help build students' confidence, although focusing instead on the difficulty level of the task. Caroline talks about how the task she proposed to students was easier the second time around and how this affected students' confidence. Toward this end, the teacher's ability or willingness to give the necessary space to students for dialogue played an important role. We can see the pedagogical

consultant, Sophie, commending Caroline for doing just that. Sophie congratulates Caroline for her “restraint”, that is, in refraining from giving students the answers even when students wander from the mathematical responses that teachers may want to hear.

Sophie: But it was good, really! Then that's what’s difficult. Then for me I do--sometimes when I'm in the classroom it's hard to hold back as a teacher, not to guide them, not to revive them, not to give them, you know, an angle, but it's because we have seen a lot of this dialogue among the students, it can emerge there. So well done Caroline. I I listened to a little bit there and then really I said like wow. (laughs) (Workshop 3, Group 3 Secondaire, [00:08:06] – [00:08:53])	**Sophie:** Mais c'était bonne, vraiment ! Puis c'est ça qui est difficile. Puis moi je fais--des fois quand je suis dans la classe, c'est difficile de se retenir comme enseignant, de pas les guider, de pas les relancer, de pas leur donner, tu sais, un angle, mais c'est parce qu'on vient beaucoup de voir là ce dialogue là des élèves, ça peut émerger là. Fait que bravo Caroline. J'ai j'ai écouté un petit bout là puis vraiment je suis fait comme wow. (laughs) (Workshop 3, Group 3 Secondaire, [00:08:06] – [00:08:53])

As our discussions progressed, categories took on emerging nuances as teachers reversed their focus. Like holding up a mirror, they turned their focus away from student struggle and instead focused on their own struggle implementing open dialogue in the classroom. Two factors—student needs/personality and emotional concerns—seemed to merge as teachers addressed pedagogical dilemmas. For instance, teachers in Group 1 remarked that students want to be rescued before struggling. Sarah concludes that helping students to stop being overly reliant on “hand-holding” takes “continuous” and “conscious” effort on the part of teachers.

> **Sarah:** Well yeah at the beginning, yeah, they were so afraid to take any risk. But I think by doing it, like all the time, now by the end of the year, they're starting to feel proud of themselves when they make a mistake and take that risk. But yeah, unless you do it, continuously, um, they still always want the hand, and once they know they're not always, you're not always going to give it to them, then they start (ha) doing it more on their own, but. It's something you have to be conscious about, so they they know 'I need to think first. I need to go through the struggle before she'll she'll give me any any help.' (Workshop 3, Group 1 Elementary, [00:53:09] – [00:54:29])

This struggle was further depicted in teachers' own struggle as they learn how best to scaffold live discussions and ultimately reflect on how their expectations of participation impact on classroom dialogue. Depicted in one telling exchange, Sophie, the pedagogical consultant in Group 3 (secondary), encourages Sylvie to utilize students' nonverbal gestures (e.g., facial expressions) as a cue to dig deeper into students' thinking:

Sophie: So you know like, I was watching, it's it's your little Michael, Sylvie, who's talking, you know, he's expressive, Michael, and he's able to. But Paul he's, he's going to be more visua-- you know, it's his, it's his facial that--even with the mask on, if he squints ((*his eyes*)) then he doesn't agree, so getting Paul to to to be able to express what his face is saying, I see it a lot there. You know	**Sophie:** Fait que tu sais comme, je regardais, c'est c'est ton petit Michael, Sylvie là, qui parle, tu sais, il est expressif, Michael, puis il est capable de. Puis Paul lui, il va le faire plus au niveau visu--tu sais, c'est son, c'est son facial qui- - même avec le masque, là il plisse ((*les yeux*)) puis il n'est pas d'accord, puis fait que c'est de laisser Paul à à à être capable d'exprimer ce que le facial dit, je le vois

when he 'And ah mm err! Not sure!' then 'Ahh.' Then you see his face. But ‘say it’ you know. That's it, that's what Paul is lacking. To go, like, to say it, when you know you see that he doesn’t agree, but there he goes--So that’s the challenge between them to challenge each other. Cynthia was not there the last time we met when I think I was away. But she could--she verbalized better there you know, ‘Ah but there you did it’ so you know. That's what was beautiful. For me, what I really liked was not hearing Sylvie, sorry Sylvie/ **Sylvie:** Ah! Psh (laughs) (Workshop 3, Groupe 3 Secondaire, [00:13:50] – [00:14:43]	beaucoup là. Tu sais quand qu'il 'Et ah mm err ! Pas sûr !' puis 'Ahh.' Puis tu vois la face. Mais 'Dis-le' tu sais. C'est ça, c'est ce qui manque à Paul. D'aller, comme, c'est de le dire là, quand que tu sais tu vois là que il est pas d'accord là, mais là il va--Fait que c'est le challenge entre eux de se challenger. Cynthia elle était pas là à notre dernière rencontre quand, je crois être absente. Mais elle elle pouvait le--elle verbalisait mieux là tu sais, 'Ah mais là toi tu l'as fait' fait que tu sais. C'est ça qui était beau. Moi ce que j'ai beaucoup aimé c'est pas d'entendre Sylvie, désolée Sylvie/ **Sylvie:** Ah ! Psh (laughs) (Workshop 3, Groupe 3 Secondaire, [00:13:50] – [00:14:43]

Another example shows a more experienced teacher, Julie (Grade 5), encouraging her less experienced colleague, Mélissa (Grade 6), not only to set up group norms using a math talk norm poster like she used, but especially to continually push her students beyond their current understanding through dialogic moves supported by a collective “math talk” poster:

Mélissa: Do you find that even if you do it at this time of year you know, that's it,	**Mélissa:** Est-ce que tu trouves que même si tu le fais à ce temps-ci de l'année tu sais,

even having done it now you saw a difference before–after?

Julie: Yes, because it--as you said it was you who said it earlier, they enumerate things rather than finding a common answer, then it stopped there. ‘Yes, but we have to find another one. You had good ideas’ so it helped a lot to push in this direction further […] Then they remembered that because we have the poster in the class. Patricia, you saw it with 'What is good math talk' and all that. Then they refer to the poster. It's really cute to see them, no, really. For sure next year I’m going to do that straight away next year in September, but it was still worth doing it this year.

Mélissa: Okay!

Patricia: Yes that was it. It was really interesting to see because I could see the difference between the two. And even though these students were used to

c'est ça, Même l'ayant fait maintenant tu as vu une différence de avant–après ?

Julie: Oui, parce que il--comme tu disais c'est toi qui disais tantôt, ils énumèrent des choses plutôt que ou ils trouvaient une réponse commune, puis ça s'arrêtait là. 'Oui mais il faut en trouver une autre. Toi, t'avais des bonnes idées' donc ça a beaucoup aidé à à pousser plus loin ce côté-là […] Puis ils se rappelaient de ça parce que on a l'affiche dans la classe là. Patricia, tu l'as vu avec 'C'est quoi une bonne discussion mathématiques', puis tout ça. Puis ils se réfèrent à l'affiche là. C'est vraiment cute de les voir là, non, vraiment. C'est sûr que l'année prochaine je fais ça de suite en en débarquant l'année là en septembre, mais ça valait la peine quand même de le faire cette année là.

Mélissa: Okay !

Patricia: Oui c'était ça. C'était vraiment intéressant de voir parce que moi j'ai pu voir la différence entre les deux. Et même

working together, uh, I just said ‘My god! Now they really build on each other.’ (Workshop 3, Group 2 Primaire, [00:04:54] – [00:06:00]	si ces élèves étaient habitués de travailler ensemble, euh, justement j'ai dit 'My god ! Maintenant ils construisent vraiment les uns sur les autres.' (Workshop 3, Group 2 Primaire, [00:04:54] – [00:06:00]

Julie even shares how she created a brand-new activity for her students. In the new activity, students are charged with creating a mini lesson to help their classmates revise the mathematics concepts they learned over the year. In small groups, students had to choose one topic out of three possibilities, amongst which Julie slipped in a concept that they had not yet seen. Julie found that her strong students immediately gravitated toward the notion that they had not yet seen while the weaker students were excited to be able to present a notion in which they were confident.

For both experienced and novice although especially for novice teachers, this appears to be a particular challenge as teachers are confronted with their own expectations and beliefs about discussion-focused pedagogy. In Group 1, a lively discussion ensued about the unpredictability of classroom discourse. At one point, Vicky says, “it never works 'cause they always come at it from some angle I haven't thought about (laughs)”. Audrey also shares how novice teachers (e.g., student teachers) may feel afraid of not knowing the answer to students’ spontaneous questions that may arise during such discussions. In the following excerpt, Audrey speaks about novice teachers; however, the underlying message inherent in her comments (i.e., new teachers feel like they are expected to know everything) reveals the struggles experienced by all teachers at some point in their career:

Audrey: I think that that was my experience too, that my student teacher was capable enough in math, but afraid of it.

Vicky: Mm hm!

Audrey: And not something that she wasn't able to teach it effectively, but she was, I think, deeply afraid of what would happen if a student asked a question she didn't know the answer (to). And I think that's something you develop with time that you were able to say, 'I actually don't know! Let's/

Vicky: /'I don't know! Let's figure it out together.'/

Audrey: /work it out. Let's let's look at it. Give me some time to think.' But I think as a new teacher starting out, it's really, that seems like a failure of a lesson, if you have to resort to 'Bah I actually don't know (if this) is your answer.' (laughs) Because you feel like you're supposed to know everything as a teacher. (Workshop 3, Group 1 Elementary, [00:58:23] – [00:59:00])

While the teachers here suggest that experience helps teacher get used to responding to the spontaneity of classroom discourse, knowing how to ensure that dialogue remains productive is far from being obvious, even to the most experienced teachers. Knowing exactly what productive dialogue might look like was not clear for some teachers, and this despite collectively working through examples and receiving materials on what types of words and expressions to look out for. In one noteworthy moment, Sophie explains to Valérie how she might identify evidence of productive dialogue in students' interactions. In these instances, Sophie advises teachers to focus on more realistic expectations of student talk ("it's never gonna be like that"). Her advice, while directive, is marked by a deep level of caring that allows teachers to positively respond to her recommendations, even if in tension with the research materials provided.

Sophie: Then maybe I could just add Valérie, you know, even if. It's not clear that your students, you know, the last time, your domino game, it was easier to say, 'Well I put my my chip down because' then the other one says 'I don't agree', you know, maybe it was, we could, you know, a problem-solving task, it's never gonna be like that, you know […] they were doing it spontaneously, 'yeah but it's not working, look, we don't arrive in the same middle.' So you know, it's going to be those little sentences. It's not going to say, 'I'm challenging you because it doesn't meet in the middle,' you know, it won't be like that. 'Hey it's not working. Look at our measurements, it doesn't work, we have a short measurement, an average measurement.' […] So there they were challenging each other, to see if even it was less, it's less of 'I challenge you, I don't agree', it was less of that that we heard. But they were doing it anyway.

Sophie: Puis là je pourrais peut-être juste ajouter Valérie, tu sais, même si. C'est pas clair que tes élèves, tu sais, la dernière fois, ton jeu de domino, c'était plus facile de dire, 'Ben je dépose ma ma pièce parce que' puis l'autre dit 'je suis pas d'accord,' tu sais, c'était peut-être, on pourrait, tu sais, une tâche de résolution de problème, ça sera jamais comme ça, tu sais […] elles le faisaient de façon spontanée, 'Ouais mais ça marche pas, regarde, on arrive pas au même milieu.' Puis tu sais, ça va être ces petites phrases là. Ça va pas dire, 'Je te challenge parce que ça arrive pas au milieu,' tu sais, ça sera pas comme ça. 'Hey ça marche pas. Regardez nos mesures, ça fonctionne pas, on a une mesure courte, une mesure moyenne.' […] Fait que là ils le faisaient se challenger, de voir que même c'était moins, c'est moins, 'Je te challenge, je ne suis pas d'accord,' c'était moins ça qu'on entendait. Mais ils le faisaient de toute

(Workshop 3, Group 3 Secondaire, [00:09:53] - [00:11:17])	façon. (Workshop 3, Group 3 Secondaire, [00:09:53] - [00:11:17])

Furthermore, the research material provided points of tension for teachers in Group 1, as well, as teachers discussed the place of positive psychology in teachers' oral feedback. For example, for my Group 1 workshop, I adapted the questionnaire items in Perry et al.'s (2020) study on research-based evidence of powerful oral feedback practices. In a game-like fashion, teachers were given the opportunity to discuss how they would respond to each of the items. One questionnaire item in particular caught teachers' attention. Teachers were asked to choose between two responses, based upon which they believed to be the most productive form of oral feedback, and then to discuss which expression best described their practice. The specific item that caused noteworthy tension read: My feedback typically (a) *leaves the student feeling good about what they've done*, or (b) *leaves the student to judge whether they have done a good job*. Audrey and Vicky responded in the following way:

> **Audrey:** Well, and I think that for myself when I look at the statement of 'Leaves a student feeling good about what they've done,' I think that I don't always mean that to. I don't always equate that with having the right answer.
>
> **Vicky:** No/
>
> **Audrey:** But just feeling good about struggling and feeling good about accomplishing something and feeling good about thinking. Uh
>
> **Vicky:** Yeah, that's true.
>
> **Audrey:** I don't. I don't know that I'm, that that statement really kind of like, I sense it should be in the, on the other side where students are judging whether they're doing well or not. But I don't know. Isn't part of school to encourage students and make them

feel like they're empowered? And if we're always expecting them to decide if they all answered the question, 'Did I do well with'--'I don't know, did you?' I don't. I don't know if that's very empowering.

Vicky: Yeah, 'cause if we if yeah, if we look at number four the way you're thinking Audrey, that making them feel good about the struggle, then the other part doesn't make sense in that context. 'Cause I just don't know or or it's confusing in that context I don't know. Yeah,

Researcher: Well, just to kind of reassure you that like this is a really tough one, right? Like you, you guys are—the the brains there ((*the tokens with pictures of brains on them*)) that you're you're, you're thinking in the right direction, but it's true that in practice, it's like maybe we wanna do both, ideally? I don't know. (laughs)

Audrey: Like I'm assuming that that statement is more about, 'do you wanna have'--if you, if you're giving the blanket statement of 'good job' every two seconds, then that's giving like almost false praise, in a sense/

Researcher: Yeah, yeah.

Audrey: It's making students overreliant on on praise. But I think there's. Maybe there is high quality feedback that leaves you feeling good if you're emphasizing on what you did well. (Workshop 3, Group 1 Elementary, [01:23:50] – [01:25:31])

Here we see Audrey battling with herself, acknowledging the importance of ensuring that students understand what they have done and why it is effective, while also being cognizant of the importance of making sure that students feel good about themselves. In fact, this episode marked Audrey so much that she would go on to talk about this point again during the post-workshop interviews: “We can't deny the importance of feeling competent or feeling good, even

in/ Like even in our own personal lives, you say like 'I'm not in it for the validation from others', but man, when you get it from someone else, it does feel good. (ha) Like you can't deny that (laughs)" (Audrey, Interview 2).

Explicit Instruction or Explicit Metacognition? Explaining the Dialogic–Metacognitive Space. Relatedly, a debate about explicit instruction also arose in groups. About an hour into Workshop 3, we began discussing the importance of identifying a clear learning objective when planning small-group tasks in the mathematics classroom. The goal of this episode was to encourage teachers to be intentional when using small-group tasks, particularly when there are specific mathematical goals to reach. I had just presented a table of scaffolding strategies for small-group tasks (instructional behaviors to promote, behaviors to avoid). As recounted earlier, these topics brought about issues such as "hand-holding". Inherent in their critiques was the understanding that explicit instruction does not allow students to go through the struggle necessary for learning. The consultant in Group 2 also touched upon this idea, challenging the "French" way of "showing (students) everything, what to do, how to do, what the authors do". She justifies her idea by referring to how mathematicians do math, saying that mathematicians "ask themselves questions". In response, Julie, who was taking university courses on classroom management at the time of the study, challenges this idea:

Julie: But it is tempting explicit instruction I find because it is precisely, you can show it explicitly, how you do, you, in your head, to ask yourself questions, to give a model. Not to say this is how I do it ta, ta, ta, ta, but how I do it,	**Julie:** Mais ça se tente l'enseignement explicite je trouve parce que justement c'est, tu peux le montrer explicitement, comment tu fais, toi, dans ta tête, pour te poser des questions, pour donner un modèle. Pas dire c'est comme ça que je

with a big problem, we can go like that with the three steps. The three-step problem.	fais ta ta, ta, ta, ta, mais comment je fais, avec un gros résoudre là, on peut y aller comme ça avec le trois temps. Le problème en trois temps puis
Patricia: That's it exactly, you know, it's not saying what to do /	**Patricia:** C'est ça exactement, tu sais, c'est pas dire quoi faire/
Julie: / No no /	**Julie:** /Non non/
Patricia: / but rather think aloud about	**Patricia:** /mais plutôt réfléchir à voix haute de
Julie: / That's it. /	**Julie:** /C'est ça./
Patricia: in what posture can we put ourselves. So it's at the level of metacognitive strategies exactly exactly. (Workshop 3, Group 2 Primaire, [01:01:16] – [01:04:01])	**Patricia:** dans quelle posture on peut se mettre. C'est donc au niveau des stratégies métacognitives là effectivement effectivement. (Workshop 3, Group 2 Primaire, [01:01:16] – [01:04:01])

Julie's point raises a critical issue regarding the difference between explicit instruction and explicit metacognition. The oversimplification that explicit instruction is somehow a bad instructional strategy hides the fact that there are indeed explicit math goals that must be reached. The emphasis, then, is not as much on how to avoid explicit instruction, often associated with IRE talk patterns. Rather, the emphasis here is to understand how best to balance a dialogic space with the curricular obligations that often leave teachers wondering when best to intervene in open discussions to direct students' attention on issues of mathematical merit.

In discussing balance within the dialogic–metacognitive space that the workshops promote, teachers share that they feel like they do not always have enough time to adequately implement dialogue-intensive pedagogies in their classroom. Valérie explains the mental process that she goes through to remind herself that the question is not so much about quantity of tasks as it is about the quality of their realization and their connection with metacognitive skills. Nonetheless, the discussions that I had outside of the workshops with the consultants revealed a genuine concern that students may not be exposed to essential learning activities if teachers did not move the lesson along more quickly. Sophie shares with the teachers during the workshop how they may have to make a difficult decision to put student-led dialogue on pause in order to move on to the "formalization" phase of the task:

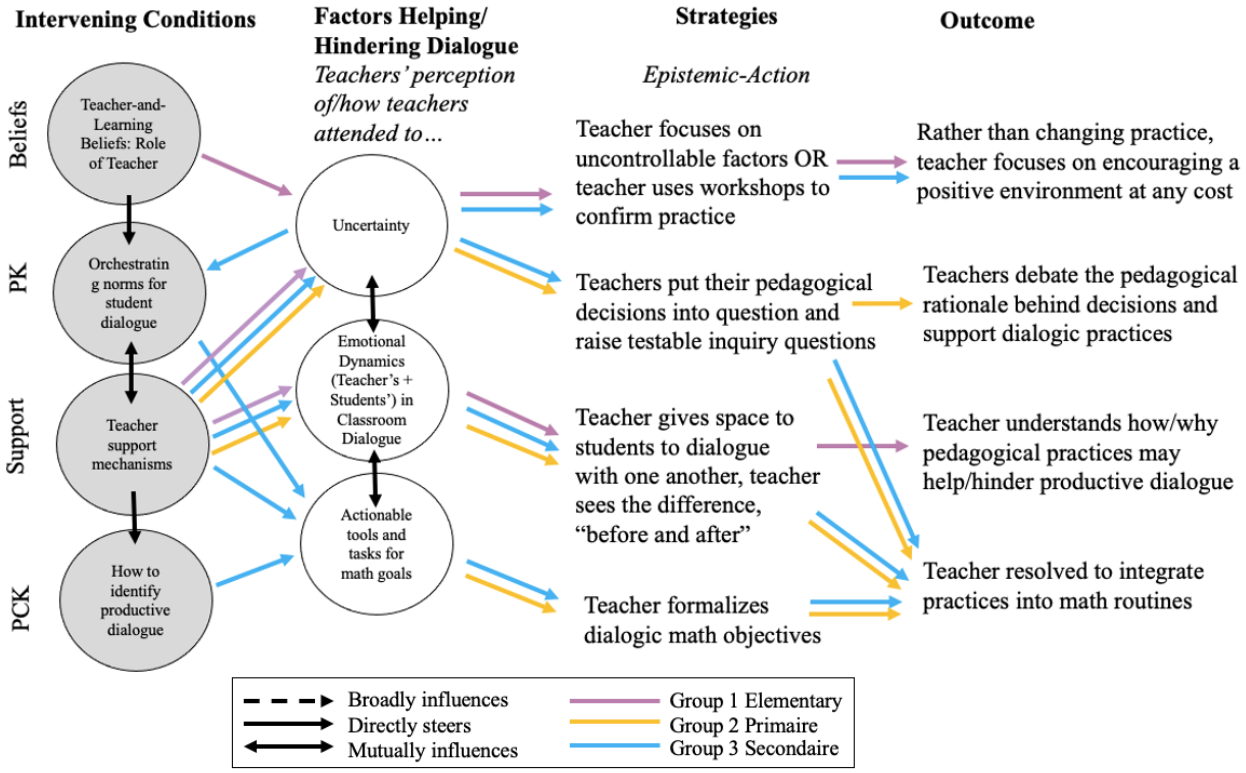
Sophie: […] at some point, you have to stop the time. Yes, we want them to dialogue. Yes, we want them to exchange but they may not all have finished the task. […] But at some point, when we feel that there is still some learning that has been done, they completed a good part of the task, what we wanted to see was put into play, then perhaps they will not have gone through to the end. Sometimes we have to cut it short in order to formalize our learning, to do a whole-group follow-up. Then it will be in another in the next	**Sophie:** […] (il) faut, à un moment donné, (il) faut arrêter le temps. Oui, on veut qu'ils dialoguent. Oui, on veut qu'ils échangent mais ils auront peut-être pas tous fini la tâche. […] Mais à un moment donné, quand on sent qu'il y a quand même de l'apprentissage qui a été fait, ils ont fait un bon bout de la tâche, ce qu'on voulait voir a été mise en jeu, puis peut-être qu'ils auront pas été jusqu'au bout. Des fois il faut comme couper court pour pour faire notre formalisation des apprentissages, faire un retour en groupe.

task which will go all the way to the end. […] Of course it's about finding a balance and all of that. (Workshop 3, Group 3 Secondaire, 00:54:39] – [00:58:10])	Puis ça sera dans une autre prochaine tâche qui iront jusqu'au bout d'une autre. […] c'est sûr que c'est trouver un équilibre puis tout ça. (Workshop 3, Group 3 Secondaire, 00:54:39] – [00:58:10])

In conclusion, the final workshop was marked by a shift from students' struggles to their own struggles teaching in discussion-rich environments. Teachers described changes made to their own practice and reflected on the impact those changes had on students, particularly on academically struggling students' confidence and motivation to participate in classroom dialogue. The pedagogical consultants and I were not silent on the matter. In fact, the workshop content and the pedagogical consultants' contributions centred on how best to optimize interactions so that teachers and students are able to benefit from this newly created culture of dialogue for students' learning in mathematics and across other subject areas. These contributions appeared to temporarily mitigate teachers' concerns, while leaving in suspension other underlying issues such as teachers' beliefs on positive psychology (whether and how to reward struggle), teachers' knowledge of learning (explicit instruction or explicit metacognition), and issues of time needed to implement dialogue-intensive pedagogies (see Figure 7). These conversations revealed teachers' deep-seeded beliefs on learning, thus bringing to light the complexity of adopting dialogic approaches.

Figure 7

Phase 4—Model of Interrelationship Between Factors Influencing the Emergence of Dialogue in the Math Classroom (3rd Iteration—Workshop 3)

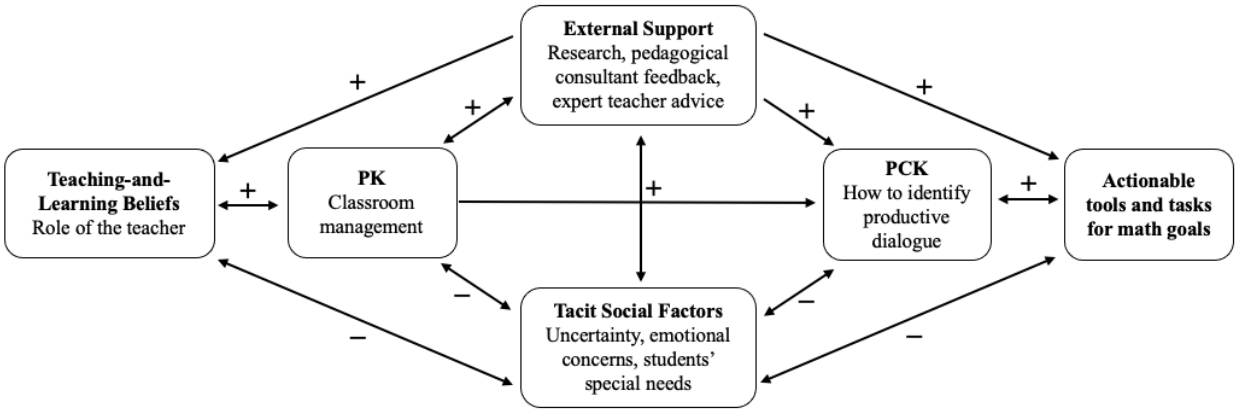


Model of Tacit Factors Influencing Teachers' Learning of Dialogic Pedagogy

A generalized model was created to synthesize the multiple representations of teachers' beliefs, knowledge, and tacit factors helping and hindering teachers' learning trajectory (see Figure 8). This model was conjectured to illustrate a theoretically stronger representation of the relationships depicted in the previous models (Figures 5-7). However, this model should be considered as complementary to earlier models. The workshop-by-workshop models created as analyses went along provide essential information key to better understanding the contexts in which categories emerged and evolved. I also argue that these complementary representations

Figure 8

Model of Tacit Factors Influencing Mathematics Teachers' Learning of Dialogic Pedagogy



Note. Arrows represent direct relationships (uni- or bidirectional) as revealed in teachers' pedagogical discourse. (+) positive relation; (-) negative relation.

further strengthen our understanding by ensuring that emergent models stay grounded in the data.

As a brief summary of the generalized model presented here: In initial phases of the study (Interview 1, Workshop 1), teachers primarily relied on their teaching-and-learning beliefs and pedagogical knowledge on classroom management to react to (rather than making sense of) dialogic pedagogy and its implications in the mathematics classroom. When presented with research-based materials that did not conform to their teaching-and-learning beliefs, or when teachers felt that research-based approaches did not fully respond to the complex social experiences faced in their classrooms, teachers' attention continually went back to students' special needs and emotional concerns. Alternatively, teachers sought help through external support, adopted research-based vocabulary, and adapted research-based resources.

In subsequent phases of the study (classroom experimentation, Workshops 2 and 3), teachers relied on their existing pedagogical knowledge and/or the external support available to

observe, test out, adapt, or simply maintain business as usual. When unexpected student behaviors or other pedagogical difficulties arose (e.g., student emotional episodes), teachers more often shifted their attention away from the negative elements of student emotions and focused instead on the way that dialogic practice allows them (teachers) and their students to engage differently and arguably more positively. In this way, the external support provided an alternative "path" from their PK to their PCK and onward to actionable tools.

Only a few of the teachers provided evidence of no or minimal change in their practice, and two showed signs of deflecting attention away from dialogic practices, although not altogether discounting the benefit of a dialogic approach or philosophy. Beliefs that teachers cannot change their classroom environment caused one teacher to underestimate her capacity to effect positive change in her pedagogy, thus deterring her from seeing the pedagogical value in the research-based tools and tasks. Alternatively, another teacher assumed that she was already implementing dialogic pedagogy when she was not. She focused on the emotional concerns of her students in an attempt to justify her which unfortunately impeded her ability to facilitate dialogue or identify productive dialogue in action.

The majority of teachers, however, expanded their existing pedagogical knowledge with the help of external support and began to ask pertinent inquiry questions to challenge their own understanding of the relationship between student dialogue and dialogic teaching practices. Thus, teachers implemented, reflected, planned, and looked ahead to future potential for dialogic practices. These cycles of collective reflection, implementation, and follow-up conversations subsequently challenge research as well, particularly regarding the dialogic space afforded by research programs (via knowledge, support, and actionable tools) that help teachers, even expert teachers, better understand the role of dialogue for learning in the mathematics classroom and

create positive change in their classrooms. Furthermore, the post-workshop interviews served to test this model, although I remained open to teachers' lived experiences and perspectives.

Research Question 3: Investigating Teachers' Learning Experiences

In the final interview, the 10 focal teachers were asked both new and old questions (i.e., some questions were drawn from Interview 1 for pre-post workshop comparison) to better understand their evolving perspectives and experiences while learning about and participating in practices that target dialogue-intensive practices in the mathematics classroom. Because the project was not evaluative in nature, questions about whether teachers used or implemented the resources provided served to better understand the processes involved in teachers' decisions to adopt (or not) dialogue-intensive practices. Thus, this debrief/follow-up interview allowed teachers to freely discuss all the aspects of the project or other aspects of their practice that were most meaningful to them.

Teachers' Self-Reported Learning

The final interview gave teachers an opportunity to discuss their learning, if any, including the elements of the workshops and classroom experimentation that were the most impactful for them.

Changes to Knowledge and Beliefs.

Workshop Content Refreshed Existing Pedagogical Knowledge. Most of the teachers (n = 7) stated that the workshops reinforced their perspectives on classroom dialogue more than changed them. At the same time, teachers from each of the three groups (Sarah, Julie, Valérie) expressed that the workshops allowed depth to their current understanding, notably by putting scientific terms to their current knowledge and experiences (Sarah, Cindy, Sylvie, Valérie).

The two teachers (Cindy, Caroline) who reported significant changes in their perspectives on classroom dialogue were teachers who either described their practices as being or were observed being structured or directive at the start of the study (e.g., teacher guides step-by-step, teacher asks simple closed questions). For instance, Cindy shared that before the study, she believed that students' written work was the only valid way to trace students' work. Now she believes that hearing students speak is just as valid as written work. She even goes on to say that taking the time to listen to students and to hear their exchanges while they are talking with their peers in groups can be even more valid because written work does not allow the teacher to get a glimpse of what is happening in students' heads. Caroline shared how, before the study, she did not believe small group activities were efficient for learning. She just thought that struggling students would copy the answers of stronger students. Now she sees how groups can be efficient, to the extent that the groups are formed well and are well explained.

Teachers Became More Critical of Their Approach to Classroom Dialogue.

Consequently, most teachers (n = 7) reported becoming more critical of their classroom dialogue. Whereas her students were exchanging, Mélissa realized that they were not really collaborating.

It's as if when we first met, in my head, dialogue, I was clear, what it was, that's it. I am not changing my mind. It really is to exchange. But I realize that my students, they weren't really exchanging. They were working in parallel or they were exchanging in parallel. (Mélissa, Interview 2)	C'est comme si quand on s'est rencontré la première fois, dans ma tête, le dialogue, j'étais claire, ce que c'était, c'est--ça. Je change pas d'idée. C'est c'est vraiment d'échanger. Mais je me rends compte que mes élèves, ils échangeaient pas tellement. Ils travaillaient en parallèle ou ils

> échangeaient en parallèle.
>
> (Mélissa, Interview 2)

This realization allowed Mélissa to understand the value of challenging as "pushing each other further" ("on va se pousser plus loin") to enrich the collective dialogue. Relatedly, Cindy describes how she can no longer sit back and let students work side-by-side without discussing and questioning one another.

For Vicky and Sarah, they were reminded of the importance of clarifying the purpose of dialogue. When discussing the practicality of the workshop content, Sarah describes how she now realizes the pedagogical value of focusing her goals and intentionally using purposeful questions during mathematical discussions (i.e., math talk):

> Mainly (I) have to focus down my goal for when I want them to talk about math. So I think before I was a little bit scattered, but then through the workshops were like 'Goal. Do you want them to like talk about themselves? How is it going to be beneficial? Uhm, this kind of problem will just give fluffy answers, but this kind of situation will give more pertinent things.' So I think, just uh different um questions that you told us maybe we should explore to get the most out of it. So I think that was. Yeah, the the math talk examples were the most beneficial. (Sarah, Interview 2)

Changes to Practice.

Moderate Changes to Teaching Practices More Broadly. The majority of teachers (n = 7) reported some type of change in their practices as a result of participating in the research project. Teachers qualified their statements of change in relation to their practices before the study began. For example, Valérie stated: "Well, of course not [any major changes] in the sense that I was already doing lots of things." ("Ben, c'est sûr pas tout court dans le sens que je faisais

déjà plein de choses. ") Valérie also mentions that, while her practice did not experience a huge change, she now uses terms from the research. She directs her students' attention more explicitly to the language they use in class. Consequently, she has noticed an improvement in students' use of the types of sentence starters and challenging phrases developed while participating in the study. Similarly, Céline mentioned that she had become more regular in announcing expectations for behavior prior to group work, which she did only sparsely before the study.

Significant Changes to Pedagogical Positioning When Facilitating Math Discussions. Rather than significantly changing their practices more broadly, teachers (n = 6) specifically described a change in their pedagogical positioning when facilitating mathematics discussions. As described earlier, pedagogical positioning refers to teaching behaviors that are indicative of a particular pedagogy or pedagogical belief. Again, pedagogical positioning does not have easily identifiable boundaries. Teachers insisted, however, on this conceptual nuance and essentially conveyed what could be described as a better alignment between their espoused pedagogy and their practice. These changes in pedagogical positioning meant that teachers became more regular, critical, intentional, or simply more dialogic in their teaching behaviors.

Six teachers described how they began providing more opportunities for students to explain their thinking, in both small-group and whole class discussion environments. Letting students talk more meant that teachers had to make efforts to talk less. Julie recounts how, even though she thought she did not talk that much before the study, she finds that she talks even less as result of participating in the study. Consequently, she describes how she is now able to observe students more. She also finds that for both herself and her students, there is less of a feeling of "working" and thus a more positive classroom climate.

The most significant changes experienced by teachers came from two elementary teachers, Vicky (Group 1) and Mélissa (Group 2). Vicky talked about how she gives more space to students to talk to each other, and not just in small groups as was already the case in her practice before the study, but also during whole class discussions. She describes how she tries not to be the sole voice of reason. When she hears students going in the right direction, she lets other students build on their peers' ideas rather than immediately intervening. For her, this was described as a significant change, one that she sees even more room for improvement. As for Mélissa, she talked about developing a "researcher's eye", or teacher–researcher perspective, as a result of participating in the study. Not only does she consciously plan open tasks that she learned about during the study, but she also asks herself now whether the small-group tasks that she plans will help her students have "real dialogue". In coherence with this teacher–researcher positioning, Mélissa shares possible hypotheses to explain why her small-group activities may not have been as productive as she might have hoped (e.g., students did not know what dialogue was or perhaps what her expectations were). She goes on to share how she plans on testing out more "things" next year.

Two teachers (Cindy, Caroline) described some changes, though nothing drastic due to the time of year (i.e., end of school year) and context (i.e., COVID-19). Cindy described her experience as being more of a realization ("ça a été plus une prise de conscience je trouve à (cette période) de l'année"). She appreciated being able to test out the activities proposed and different ways of doing group activities but foresees the major changes taking place during the next academic year when she can implement changes as soon as the school year begins. Caroline also expressed not being able to make major changes until the next academic school, highlighting the context of the pandemic that demanded a lot of changes already. She does

describe how she currently has been giving students more opportunities to explain their thinking, to hear more ideas from their peers, to come to a consensus together, and to give reason why they retain particular ideas. These metacognitive prompts, while guided by the teacher, allow students to become more involved in the process of their learning. Caroline shares how she would like to do more small-group activities in her future practice.

Influence of Changes. When teachers were asked specifically what they believed influenced the changes they experienced in their practice, the majority of teachers ($n = 6$) associated change with participating in the research study. Four of these teachers (Audrey, Caroline, Mélissa, Valérie) expressly pointed to the theory on productive dialogue moves. While Sarah also mentioned elsewhere the importance of the theory on her understanding of her students' development of self-regulation, she principally relied on the support from the researcher and fellow teachers to allow her to see the importance of persevering despite the difficult class she had this year. Caroline shared that she found the presentation on collaboration and metacognition in service of math goals to be very logical, which aided her motivation to change. Two elementary teachers from Group 2 who were also team-teachers (Mélissa, Cindy) found the tasks provided in the study to be a non-negligible factor in their change in practice.

The remaining teachers either reported self-motivating factors that influenced their change, such as motivation to encourage more student-centred talk (Vicky) or the teacher's own curiosity to learn (Julie). The remaining teachers (Céline, Sylvie) did not recount, nor were they observed, adapting/modifying their practice beyond superficial changes. It is worth noting that Céline and Sylvie both teach classes for students with significant learning difficulties. Céline would also go on to recount how, even with minor changes, she managed to see noteworthy responses in her students' classroom participation (see *Surprising Learning Moments*).

Teachers Report Significant Positive Changes in Student Interactions. When asked about students' level of comfort building on or responding to their peers' ideas during whole class discussions—in other words, in a relatively public setting opposed to the private interactions of small-group tasks—most of the teachers observed a net increase in comfort. On a five-point Likert scale question, teachers' (n = 10) average score for student comfort at the end of the study was rated at M = 3.3 (SD = 0.63), compared to their average rating of M = 2.3 (SD = 0.9) at the beginning of the study.

Nearly all the teachers (n = 9) emphasized the importance of seeing the differences in classrooms, particularly in student interactions. Changes in student interactions were often associated with specific strategies that teachers began putting into place. Consequently, some teachers reported that they were hopeful that next year's students would experience that much more powerful changes given what they were already able to see in their students' exchanges, confidence, and motivation after only a few months' time (i.e., duration of the study).

Teachers Plan to Use Resources in Future Practice. Additionally, most of the teachers (n = 9) found the materials, particularly the student-centred materials, useful. Many of the teachers (n = 7) even plan on using the resources in their pedagogical practices the following year. A summary of the resources/tools that teachers found to be useful or plan to use in future practice can be found in Table 7. Teachers across both levels, elementary and secondary, most often reported the student-centred resources to be the most useful. The most often reported were the student self-assessments, the observation checklists, and the sentence starters for encouraging more math talk.

In contrast to student-centred resources, teacher-centred resources were the least mentioned. Teacher self-assessments were reported only once by an elementary teacher who,

Table 7

Resources That Teachers Found Useful and Plan to Use in Future Pedagogical Activities

Name of resource	Reference/Source[a]	# of teachers who used/liked the resource	# of teachers who plan to use resource in future teaching activity
Microsoft Teams	Study environment	8	7[b]
Small-group scaffolding tips	Dixon et al. (2018)	1	0
Open math tasks (Which one doesn't belong? Open Middle)	Online resource	4	1
Metacognitive knowledge	Study-based[c]	1	0
Padlet/4 C's (teacher-centred online activity)	Study-based, Lipman (2003)/Phillipson & Wegerif (2019)/ Sutcliffe (n.d.)	2	2
Group norms/Norms for dialogue	Study-based, teacher-generated during workshops	3	2
Open questions	Study-based	0	2
Dialogic moves schema	T-SEDA	1	0
Teacher self-assessment	T-SEDA	0	1
Student self-assessment	T-SEDA	5	1
Observation checklists	T-SEDA	4	0
Reflective cycle of inquiry	T-SEDA	0	0
Sentence starters, math talk examples	Teacher-generated during workshops	3	0
Metacognitive self-assessment for students	*Teacher-initiated, inspired by workshop material	0	1
Teacher-student interview	*Teacher-initiated, current practice	1	0

Note. [a] In contrast to materials provided or created during the workshops, teachers may mention their own tasks, indicated here by an asterisk (*). [b] Of the seven teachers interested in online PD, one teacher believes it depends on the task while another likes both in-person and online.

[c] 'Study-based' refers to materials that were made expressly for the workshops.

during Interview 1, shared that she was not always sure whether her practices were optimal. Additionally, only one elementary teacher actively investigated the dialogic moves schema which provides teachers with specific examples of questions and prompts that they can use to reflect on and expand their repertoire of dialogic questioning practices. As revealed in one teacher's reaction to the reflective cycle of inquiry, teacher-centred activities ideally suited for teachers' individual reflection outside of workshops were considered too time-consuming.

Teachers (n = 5) mentioned appreciating the "pratico-pratique". For example, teachers shared how they appreciate it when proposed tasks correspond to what teachers already do, when tasks can save teachers time, and when ideas are easily transposable into their practice. One teacher's account suggested that she intuitively chooses ideas that are similar to her current practice.

Teachers' Critical Learning Trajectories

In addition to teachers' self-reported learning, teachers' conceptualizations of dialogue and productive dialogue went through changes, particularly in the way they view their own role in classroom dialogue.

Shifting Conceptualizations of Dialogue and Productive Dialogue. When compared to pre-workshop interview responses, teachers' descriptions of dialogue shifted from a mix of student- and teacher-centred definitions to conceptual descriptions (Table 8).

Five teachers (Céline, Cindy, Julie, Mélissa, Valérie) adopted research-based examples of productive dialogue moves (e.g., active participation, building, challenging, questioning, explaining reasoning) within their definitions of dialogue.

Table 8

Phase 4—Teachers' Post-Workshop Conceptualizations of Dialogue

CATEGORY/**Sub-category**/Code	**# of teachers**	**Code frequency**
DIALOGUE		16
Conceptual understanding	**10**	11
Talking with one another, exchanging		3
Building together + explaining reasoning		3
Not just working in parallel, but collaborating and challenging one another		3
Learning through exchanges, arriving at a consensus		2
Teacher-mediated dialogue	**4**	5
Teacher clarifies expectations for dialogue, models examples of dialogue		1
Teacher verifies that students' talk is going in the right direction		1
Teacher uses reverse psychology so that students want to talk math		1
Teacher asks students open questions, gets students to question their answers		1
Opposite of stand and deliver, teacher allow collective exploration		1

Specific examples of changes in pre-/post-workshop definitions can be seen in the following quotes:

Interview 1

Sharing. Helping one another. Yeah it's a bit like that. Yeah sharing and helping one another. (Julie, Interview 1)	Partage. Entraide. Ouais c'est un peu ça. Ouais partage et entraide. (Julie, Interview 1)

Interview 2

Well now it's, it's not just talking, discussing, it's really it's participating,	Ben maintenant c'est, c'est pas juste parler, discuter, c'est vraiment c'est participer,

building something together, not necessarily being sure--agreeing either, but giving reasons why you disagree. (Julie, Interview 2)	construire quelque chose ensemble, pas nécessairement une sûr--être d'accord non plus, mais donner des raisons de pourquoi on n'est pas d'accord. (Julie, Interview 2)

Sarah and Caroline expanded their definitions of dialogue by further emphasizing the learning goals of talk. As seen in the following quotes, Sarah went from 'talking for talking' ("an exchange of ideas") to 'talking for learning':

Interview 1

> (When) I hear dialogue, I think of students actually talking about what they're learning and how they're learning it to one another. (2.0) So like the an exchange of of their ideas with one another. (Sarah, Interview 1)

Interview 2

> I guess having a discussion to enhance your learning. So you're learning through the exchanges that you do with others. (Sarah, Interview 2)

There were no obvious changes in Audrey, Vicky, or Sylvie's definitions of dialogue.

As in Interview 1, teachers were also asked to describe what productive dialogue looks like in their classroom (see Table 9). One of the first observations that stood out was the way outcome-oriented conceptualizations of productive dialogue shifted overall from individual achievement to collective achievement. In other words, when outcomes were mentioned in pre-workshop interviews, responses tended toward individual advancement or achievement on written tests. In contrast, post-workshop interviews included responses such as "everyone" in the group understands or "all of the students" in a group are able to explain the reasons why they choose one solution or another.

Table 9

Phase 4—Teachers' Post-Workshop Conceptualizations of "Productive" Dialogue

CATEGORY/**Sub-category**/Code	**# of teachers**	**Code frequency**
PRODUCTIVE DIALOGUE		26
Verbal/Interactional signs of productivity	**8**	12
Students aren't afraid to challenge one another, get peers to share		3
Everyone contributes to enrich the dialogue		2
Ah ha moments emerge, students begin to ask thoughtful questions, less "helpless"/"rescue me" questions, more autonomy seeking		2
Students explore multiple solutions to math problem		1
Students ask for/provide reasoning while putting themselves into question ("tout ça dans le respect")		1
Students truly work together, not just side-by-side		1
Building on one another's ideas		1
Students don't let uncertainty prevent them from sharing		1
Mediated productivity	**8**	9
Teacher selects math content/tasks conducive to productive dialogue		3
Teacher consciously lets students build on their peers' ideas		1
Teacher doesn't take it for granted that students understand what productive dialogue is		1
Teacher models productive talk moves, explains expectations for talk		1
Teacher asks questions to guide student earning, not just talk for talk		1
Teacher clarifies math goal toward which students work together to achieve		1
Teacher encourages/supports student-generated ideas		1
Outcomes as productivity	**4**	5
Everyone is able to explain why they think one way or another		1
Everyone in the group understands		1
Students change their way of thinking		1
Students successfully arrive at the math goal together		1
Students understand a concept they never understood thanks to exchanges		1

There were also notable differences in teachers' descriptions of verbal/interactional signs of productivity. In the pre-workshop interviews, three teachers (Caroline, Sylvie, Vicky) had already mentioned the importance of challenging and questioning for productivity in groups. This idea was also extensively highlighted during the workshops. Consequently, in the post-workshop interviews, five different teachers (Audrey, Sarah, Cindy, Valérie, Céline) than the three just mentioned cited the importance of challenging and questioning one another's and one's own ideas. What's more, all eight of the teachers who mentioned challenging and questioning—whether during the pre-workshop interviews or the post-workshop interviews—highlighted the socio-emotional considerations involved. For example, Valérie expressed that, for dialogue to be productive, "students can't be afraid to challenge one another either" ("faut que les élèves aussi n'aient pas peur de challenger les autres"). For this to happen, Céline and Sylvie highlight how important it is for students and teachers to show respect to one another.

With considerations of students' fear of judgment, fear of exclusion, or feelings of uncertainty, teachers in the post-workshop interview were more resolute about their role in ensuring that students are given a safe space to challenge and question ideas. While some teachers initially viewed their contribution to productive dialogue as relatively passive, as evidenced in teacher descriptions of productive dialogue (Interview 1), teachers adopted (and in some cases maintained) an active stance in post-workshop interview responses, emphasizing the need to be intentional with the math content and tasks chosen with dialogue-intensive methods, to clarify expectations and goals (for classroom dialogue and for math), and to continually provide support toward collaborative and curricular goals.

Unlike in the first interviews, teachers did not mention non-verbal signs when asked about productive dialogue. This finding suggests that teachers' conceptualization of productive

dialogue (i.e., what makes a dialogue productive) became more concretized as teachers began to focus on concrete instances of teacher-mediated dialogue. Instead, non-verbal signs (e.g., something teachers see "in students' eyes") appeared to be more closely related to a pedagogical catalyzer, encouraging teachers to continue persevering despite the challenges met while adapting to dialogue-intensive pedagogies. Cindy's response conveys this idea:

So to see that successful students (1.0) have answers, but that students who have difficulties have just as good answers uh. I think that for a teacher, seeing the pride in the eyes of the students, it can't be anything other than a motivation to continue or to persevere in something with which one is perhaps less skilled (1.0), used to and all that. So that, for me, the esteem that I saw in my students, the confidence in them, well for me, it's like my motor. (Cindy, Interview 2)	Donc de voir que des élèves (1.0) performants ont des réponses, mais que des élèves qui ont des difficultés ont d'aussi bonnes réponses euh. Je pense que pour une enseignante, c'est de voir la fierté dans les yeux des élèves, ça peut pas être autre chose qu'une motivation à continuer ou à persévérer dans quelque chose avec lequel on est peut-être moins (1.0) habile, habitué tout ça. Fait que, pour moi, ça l'estime que j'ai vu chez mes élèves, la confiance en eux, ben moi, c'est comme mon moteur là. (Cindy, Interview 2)

Additionally, teachers spoke of the challenges of scaffolding dialogue as they (Vicky, Sarah, Cindy, Mélissa, Caroline, Céline) realized the essential role that they played in ensuring the emergence and maintenance of productive dialogue in the mathematics classroom and in their practice more generally.

Furthermore, five teachers (Sarah, Cindy, Mélissa, Valérie, Céline) began to envision productive dialogue as being ubiquitously anchored in their practice, for some specifically within their mathematics routines, for others within their practice more broadly. For example, Mélissa and Cindy made the following remarks:

You know because a QELI [Which one doesn't belong?] when you--you know when it's anchored in our routines, then we do a QELI a week, an Open Middle a week and then for example another activity or something else. I think it's going to become, it becomes fixed. (Mélissa, Interview 2)	Tu sais parce que un QELI [Quel est l'intrus ?] quand on--tu sais quand c'est ancré dans nos routines, puis qu'on fait un QELI par semaine, un Open Middle par semaine puis par exemple une autre activité ou autre chose. Je pense que ça va devenir, ça devient ancré. (Mélissa, Interview 2)

Then we--I tried, I'm still trying to go uh even in other subjects, to say 'Well what we do in mathematics, it's in French too. When we analyze a sentence, we--sometimes yes, one, the verb, it will remain a verb, but in our analysis, our verb can be in different places.' (Cindy, Interview 2)	Puis on--j'ai comme tenté, je tente encore d'aller euh même dans les autres matières, dire 'Ben ce qu'on fait en mathématique, c'est en français aussi. Quand on analyse une phrase, on--des fois oui, un, le verbe, il va rester un verbe, mais dans notre analyse, il peut être à différents endroits, notre verbe.' (Cindy, Interview 2)

Toward Reflection: Seeing One's Class as if From the Outside. As conveyed in the analyses of workshop discourse, different factors appeared to influence whether teachers

reflected, and these were confirmed in teachers' own accounts of their learning and change during the workshops and classroom experimentation. The first factor observed was in teachers' capacity to see their classroom as if from the outside. Different affordances allowed teachers to do this, namely through the workshops, pedagogical consultant, and student teachers. For example, Julie shared how the dialogic practices encouraged in the workshops allowed her to take a step back and to just observe her students. Sarah, Cindy, and Caroline spoke of the research study itself, as if it gave them the permission to let students have more space to just talk with one another without worrying that students are not learning.

> I found it interesting to listen to them just to ((*holds mouth closed with fingers*)) stay like that. (haha) Then to let them go, then, uh, you know precisely to see that they are capable by them--you know, by themselves even just to go part of the way. You know, since, you know, sometimes you just need to steer them a little bit. (Caroline, Interview 2)
>
> J'ai trouvé ça intéressant de les écouter justement de ((*ferme sa bouche avec ses doigts*)) me tenir comme ça. (haha) Puis de les laisser aller, puis, euh, tu sais justement de voir qu'ils sont capables par eux--tu sais, par eux autres même de faire un un bout de chemin. Tu sais, puisque, tu sais, des fois t'as juste besoin de les aiguiller un peu là. J'ai, j'ai trouvé ça intéressant. (Caroline, Interview 2)

According to two elementary teachers (Group 2), the assistance of the pedagogical consultants, specifically their presence in their classrooms, aided teachers' reflective practices. Two different elementary teachers (Group 1) also mentioned the presence of student teachers in their classrooms as useful resources for reflecting as if from the outside.

It is important to note that teachers' access to their own classroom recordings was not often used as a reflective tool. Only one teacher watched the videos (Julie). Two others (one elementary, one secondary) cited a lack of time and fear of being too critical as reasons for not watching the videos. Rather, teachers relied on their memory of classroom events.

Challenging Mirror Moments. In the final interviews, teachers recounted the difficulty they met to put their own practices into question, even if they already believed in the rationale of the study (i.e., importance of dialogue for learning in the mathematics classroom). Both Julie and Mélissa admit that they thought their classroom dialogue was very productive before joining the study. Mélissa even admits that she was very proud of the way that she had come to organize small-group tasks. Julie now realizes that dialogue was rare in her classroom before the study. Similarly, Mélissa realizes that she had largely taken for granted how prepared students were to participate in dialogue with their peers. When asked whether the workshops or other aspects of the study changed her perspective on dialogue or her perspectives on small-group activities, Mélissa gave the following response:

Mélissa: (4.0) Well yes, in the sense that you know I said a lot in my first interview, I remember we talked about (group work), then the fact that we were going to set some up, that I had set some up. And that was something that I was proud of. And it's still something that makes me proud. But I thought that was a lot of dialogue. Then in the end, it really	**Mélissa:** (4.0) Ben oui, dans le sens où tu sais je disais beaucoup dans ma première entrevue, je me souviens qu'on a parlé des ateliers, puis du fait qu'on en mettait en place, que j'en avais mis en place. Puis c'était quand même quelque chose qui me rendait fière. Puis c'est toujours quelque chose qui me rend fière. Mais je pensais

wasn’t that much. (2.0) But maybe it's just that my students weren't equipped well enough because I hadn't necessarily modeled well. You know, I had already modeled a way of doing things, a way of discussing and all that, so, so, it was difficult to undo that. (Mélissa, Interview 2)	que c'était beaucoup du dialogue. Puis au final, ça n'est pas tant. (2.0) Mais c'est peut-être juste que mes élèves étaient pas assez bien outillés parce que j'avais pas nécessairement bien modélisé. Tu sais, j'avais déjà comme modélisé une façon de faire, une façon de discuter tout ça, fait que, fait que, c'était difficile de défaire ça. (Mélissa, Interview 2)

It also became challenging when teachers struggled to reconcile the research-based materials with their pedagogical beliefs and sometimes very detrimental classroom experiences. For example, when asked to define “dialogic teaching”, one elementary teacher from Group 1 equated it with any “good” teaching (“I think all good teaching is dialogic in a way”). Despite seeing the positive sides of dialogic teaching, she describes the impossibility of dialogic teaching, which she describes as “slow paced”, during a time when teachers need to “catch up” on lost time due to pandemic shutdowns. Her distress is further escalated by a classroom dynamic which she describes as “toxic”, making it difficult for her to connect “philosophy and the reality.”

Teachers’ preconceptions regarding participation in research was also challenged. Céline recounts how the open format of the research study got her out of her comfort zone, whereas she is accustomed to more directive study formats. In contrast, this open, collaborative format of the study, while challenging, motivated Audrey, Cindy and Mélissa. They each expressed that they were open to challenging themselves even more through more advanced study formats, such as

collaborative curriculum design. In designing tasks with other teachers, these elementary teachers hope to “feel” what students feel, to “walk in students’ shoes”, and to “see other people in action”, creating and designing together. These three teachers felt this was lacking in the workshops.

As for me, I'm like, in my brain, it seems like that’s how it works there, I need examples. I would have liked that, to be able to live an activity in the same way that I made my students live. (Cindy, Interview 2)	Moi, je suis comme, dans mon cerveau, on dirait que ça fonctionne là, j'ai besoin de d'exemples. J'aurais aimé ça, pouvoir vivre comme une activité au même titre que j'ai fait vivre à mes élèves. (Cindy, Interview 2)

It so happened that two activities were implemented with this goal in mind (i.e., putting teachers in the shoes of students). However, teachers (Group 1), rather than fully participating in the activity as a student would, preferred to focus on what their students would do in the same situation:

Researcher: Okay. So your task is to uhm, think about and to choose which sequence doesn't belong. So I'll give you a couple minutes to think about it by yourself, and then we'll start discussing what what's what, we might, what we see in these different sequences.

Vicky: I found three that don't belong for different reasons.

Audrey: I think that's the point though. /Is that there are like so many answers./

Vicky: /Yes! Right. Exactly. Yes./ There's not only one answer.

Researcher: (Vicky), would you like to open us up? You can go ahead and start uhm, maybe talking about some of the things that you noticed.

Vicky: Uh, I know that the ones that students would pick up right away is the box number one is the only one that has, um fractions with different denominators.

[…]

Audrey: Uhm. Superficially, students will say box three has a fraction as a decimal, and they'll probably tell you it's wrong.

Vicky: Yeah (laughs)

Audrey: (laughs) 'You can't have both!' (laughs) that'll cause its own debate.

(Group 1, Workshop 2, [00:39:40] – [00:41:55])

Coincidentally, none of the discussion activities planned with this goal in mind took place in Groups 2 and 3 either because, on one side, timing issues arose due to longer time dedicated to teacher discussions (Group 2) and technical failure (Group 3). In one instance, the pedagogical consultant assumed that teachers were already familiar enough with the activity and requested that we pass through to other topics. In another case, the consultant took over discussions, not always giving teachers the opportunity to respond to the discussion activities, to skim through the main points before the end of the workshop. In yet another case, one of the consultants expressed that she preferred not to do one of the activities because she was not certain the teachers would understand the purpose, adding that the content was too advanced for the participating teachers. Consequently, I decided to exclude it to respect the consultant's hesitations.

Pros and Cons of Collaborating With Other Teachers. Collaborating with other teachers was not without its own challenges. More generally, teachers were asked how they found the experience of participating in the research project. Responses ranged from enjoyment ("I really enjoyed it") to appreciation ("I found the study to be really enriching") with one

teacher expressing moderated appreciation due to the discomfort of filming herself teaching ("Apart from the video, the rest was fine."). Three teachers (2 elementary, 1 secondary) expressly mentioned the benefit of being able to follow one small group of students over time, and the benefit it had on their own teaching practice ("I've never participated in a study […] (where) we followed a group of students. I loved that.").

All in all, teachers appreciated meeting with other teachers. Most of the teachers (n = 7) expressed that they benefitted from the different perspectives or experiences of other teachers. One secondary teacher even shared that meeting with teachers was, for her, the most interesting part of participating in the research project. Teachers' discourse centred on the notion of comparison, comparing their practices to that of different teachers, schools, or the practices of pedagogical consultants. One secondary teacher mentioned how comparing her practices to others' practices allows her to break away from her routine. A Grade 5 elementary teacher shared how she appreciated being able to see where her students were going next year thanks to the exchanges she had with the pedagogical consultant and the Grade 6 teachers.

Other teachers (n = 3) teachers found that meeting with the small group of teachers were beneficial for them on the social level, particularly given the current context of the pandemic. An elementary teacher talked about how the meetings broke the feeling of isolation felt by teachers, specifically during a time like this one when teachers could not meet due to the pandemic. Similarly, another elementary teacher from the same school board shared how online meetings organized with 50+ attendees made it difficult to interact with other teachers during the pandemic. Two teachers (one elementary, one secondary) described how they really enjoyed just being able to discuss pedagogy with other teachers. Ironically, the secondary teacher shared how

this is not always possible during pedagogical days which get quickly filled up by committees, assemblies, and meetings with parents.

In contrast to the positive experiences cited above, two teachers (one elementary, one secondary) found it uncomfortable to meet with the other teachers present. The elementary teacher shared how she was “a little bit intimated at first” to be with more experienced teachers whom she has “seen around” but with whom she had not yet met. Nevertheless, she gradually grew to appreciate being able to hear how they organize their classrooms. The secondary teacher, on the other hand, found it “weird” to hear more experienced teachers share what they were discovering, as if for the first time. This destabilized this teacher who assumed that the workshop content should be obvious to any experienced teacher. Consequently, she was hesitant to share her perspectives during the meetings for fear of being perceived as “bragging”.

Surprising Learning Moments. There were also unexpected learning moments that emerged during teachers’ final interviews. These learning moments were surprising in that they dealt with ideas that went beyond the workshop aims. The first observation made by three different elementary teachers (Cindy, Julie, Vicky) was that there was a notable, positive difference in boys. Julie recounted how one boy who rarely talked during group tasks before the study began talking consistently throughout group tasks. Cindy also shares how a parent came to her remarking a positive change in her son, which Cindy attributes with his participation in the research:

The mother, she said, ‘it’s like there’s a change.’ But I said, ‘I don't know, but’ I said, ‘(with) him, the research, it made it so that he never comes to see me again	La maman, elle disait, ‘il y a comme un changement.’ Mais j'ai dit, ‘Je le sais pas là, mais’ j'ai dit ‘Lui, la recherche là, ça a fait en sorte que il vient plus jamais me

saying “I don't understand anything.” He is able to put into words what he doesn’t manage to do.’ (Cindy, Interview 2)	voir en me disant “je comprends rien.” Il est capable de mettre des mots sur ce qu'il arrive pas à faire.’ (Cindy, Interview 2)

Vicky also observed productive interactions between boys who do not normally work well on their own, on the condition that they choose their teammates.

Céline also remarks, with her secondary students, a change in their strategy for choosing teammates. Before the study, her and her team-teacher regularly gave students the freedom to choose their groups. She recounts that it was not rare to observe less than ideal interactions between certain students. With the study, Céline began using the research-based student checklists (adapted by Valérie) in all her classes along with the norms for dialogue. To her surprise, students began choosing teammates not by affinity, but by efficacy, leading to groupings that she would have never imagined before the study. Consequently, she has noticed a net improvement in the efficiency of students’ group interactions.

As the next example shows, teachers’ experiences in studying dialogic pedagogy may also spark their curiosity in the personal sphere. Considering the study goals, Valérie decides to share how her 3rd grade daughter manages to understand and explain the basic concepts of negative integers by simply presenting her daughter with a challenge and then letting her explain her thinking. In this same episode, Valérie makes it very clear that assessing students individually remains a challenge. However, as seen through her anecdote, she is convinced that allowing more room for students to talk remains a productive pedagogical decision.

Teachers accounts also reveal transfer of the study’s content to other professional spheres. For example, Cindy recounts how she and Mélissa have begun building on and challenging one another during their team-teaching preparation. This change is similar to

observations of teachers' workshop discourse gradually shifting from building on one another's ideas to challenging and questioning their practices and understandings as teachers iteratively implemented the research-based resources and reflected on their classroom experiences. Sylvie even shares how participating in the study gave her the courage to sign up to have a teacher intern, which was not something that she was readily open to at the outset of the study. She describes the feeling of wanting to pass on to others what she was given when she began teaching. She believes that the study helped her realize that she had something to give others.

Chapter 5: Discussion

Dialogic pedagogy has been shown to benefit student learning by providing a supportive culture of dialogue (Alexander, 2008; Berkovitch, 2016; van der Veen & van Oers, 2017) that fosters the social and cognitive health of classrooms (Mercer & Littleton, 2007).

Despite the learning potential of dialogic approaches and practices, dialogue-intensive pedagogies remain on the margins of practice (Howe & Abedin, 2013). Unquestionably, teaching is complex, and integrating new pedagogical knowledge and philosophies associated with dialogic pedagogy, or dialogue-intensive pedagogies more broadly, cannot be taken for granted. Understanding how teachers learn dialogic pedagogy necessitates careful attention to teachers' contexts, tacit knowledge, and beliefs about teaching-and-learning activity. As seen in the literature, learning about and adopting dialogue-intensive pedagogies has been shown to provoke strong reactions from teachers: skepticism if teachers do not believe their students to be mature enough to participate in productive dialogue (Murphy et al., 2018; Vrikki et al., 2021); negative emotions if teachers perceive student-led dialogue to put their classroom control at risk (Chee et al., 2015; Curtis et al., 2020; Lloyd, 2008; McAneny, 2013).

In collaboratively exploring dialogic philosophies with teachers and pedagogical consultants, this study provides a closer look at some of the challenges as well as the opportunities available to facilitators wishing to promote dialogic pedagogy with mathematics teachers. In so doing, not only do we learn about the processes and mechanisms, particularly the psychological factors (tacit knowledge, beliefs, motivation), influencing teachers' adoption of dialogic pedagogy, we also get a glimpse of how a small group of mathematics teachers manage to surpass difficulties and persevere despite uncertainties amidst a backdrop of COVID-19.

Moreover, this study sought to investigate how a group of elementary and secondary mathematics teachers learn dialogic pedagogical approaches for mathematics education as a result of participating in three cycles of online collaborative workshops and classroom experimentation. A constructivist grounded theory approach was utilized to explore the tacit factors that influence teachers' learning and to explain why teachers may or may not adopt dialogic approaches in their classrooms. Multiple forms of pedagogical discourse were collected and analyzed, namely pre-workshop interview responses, workshop discussions, teacher-student talk, and post-workshop debrief interviews.

RQ1: Teachers' Lived Experiences and Perspectives on Dialogue for Learning in Mathematics

Motivation to Learn at the Outset of the Study

While physical distancing protocols and unexpected shutdowns due to the COVID-19 pandemic continued to complicate teachers' use of peer-led small-group and project-based tasks, teachers were nonetheless interested in knowing more about research-based strategies for conceptualizing and implementing dialogue-based strategies in the mathematics classroom, particularly within whole-class discussion settings. In a very rich phenomenological account of mathematics teachers' retrospective reflections on their experiences learning in a professional development program focused on teacher discourse moves, McAneny (2013) learned that most of the teachers wanted to participate in the PD out of motivation to learn; although, others opted for the program because it was perceived as less demanding than another PD alternative available to them. While teachers may be genuinely curious to learn, they may also be motivated to participate in research if they already perceive themselves to be relatively competent in the focal pedagogy.

In this study, and somewhat unexpectedly, all but one teacher had a notable link to pedagogy adapted to students with learning difficulties. In talking with teachers during pre-workshop interviews (Interview 1), it also became evident that this group of teachers possessed a wealth of knowledge and experience teaching using small-group tasks, broadly construed here as one of the foundational practices used in dialogic teaching. This observation speaks volumes to the profile of teachers who are interested in participating in studies that seek to deepen knowledge of dialogic scaffolding strategies. Indeed, most of the teachers were relatively at ease proposing student-led activities in their mathematics classroom, even if not always certain of the efficacy of their strategies. These observations echo the motivational factors described in Hennessy et al.'s (2011) study.

Additionally, the presence and support of other educators was also a non-negligible theme emerging in the data. Half of the participating teachers described regularly working alongside another adult educator (e.g., team teacher, resource teacher). Some were even currently supervising student teachers. More often, however, teachers focused on how their dialogue-based routines were interrupted by COVID-19. Two elementary teachers recounted how COVID-19 constrained them to interrupt their usual team-teaching routines. As there was some return to in-person learning at the time of the interviews, the hope of an ameliorating situation encouraged teachers to participate in this dialogue-focused research project.

Intuitive Conceptualizations of Dialogue and Pre-Intervention Beliefs About Learning in Groups

As shown in previous literature (Colonis, 2011), teachers' interview responses were key to ascertaining how teachers use and intuitively conceptualize dialogue-related terminology and dialogue-intensive approaches. As Davies et al. (2017) demonstrated, integrating pre-/post-

intervention interviews as a primary data source allows us to better understand the shifts in beliefs experienced by teachers when learning about dialogic pedagogy, which has heretofore been lacking in the literature (Kiemer et al., 2015). This study has provided these essential sources of data.

At the outset of the study, the notion of productive dialogue challenged teachers' conceptualizations of student learning of mathematics in collaborative contexts. When asked to elaborate their understanding of productive interactions during dialogue-rich mathematics tasks, teachers mostly described implicit learning processes and outcomes, notably nonverbal components (e.g., when students' eyes glow with excitement). On one hand, these socioemotional factors are very useful for teachers to assess whether students are experiencing positive emotions (e.g., students are motivated, students' attention is activated). Indeed, research has demonstrated the positive relationship between emotions and achievement (Goetz & Hall, 2013; Pekrun, 2006). However, some teachers use signs of motivation and enjoyment as a proxy for student learning. This is a significant finding because it partially explains why in prior research on classroom interactions positive emotions in dialogue do not always translate to positive student achievement (Cheng et al., 2015).

These findings also gave further impetus to the PD workshop sessions on metacognition, as prior research has shown the combined effect of dialogue and targeted metacognitive instruction on student learning in mathematics (Artz & Armour-Thomas, 1992; Goos et al., 2002; Kramarski, 2004; Taylor & Cox, 1997), science (Felton et al., 2015) and social studies (Cohen et al., 2002). While teachers in this study demonstrated a strong working knowledge of metacognitive processes important for student learning, this knowledge remained largely implicit, evidenced by the high frequency of unsolicited demonstrations of knowledge of

metacognitive processes promoted during student-led small-group tasks (emotion regulation, goal setting, strategy awareness), but a low frequency (i.e., only two teachers) of explicit individual and collective monitoring or reflection. Interview responses suggest that teachers want to ensure that group work is a fruitful intellectual endeavour for the co-construction of knowledge, but teachers may not know how best to capitalize on the knowledge that we know today about dialogue and learning.

Contrary to prior research on dialogue, this group of mathematics teachers viewed dialogue as an essential learning outcome and not just a springboard to "real" learning (Kubanyiova, 2015). In fact, most of the participating teachers were already convinced that student-led discussions (e.g., small-group tasks) can benefit students' learning, even if they were not always sure how this happens. Most of the teachers reported regularly using small-group tasks and reported that their small-group routines greatly contrasted that of most of their colleagues who rarely (or incorrectly) organized collaborative tasks. However, teachers cautioned that small-group tasks demanded a great amount of time and energy. Disparate classroom composition, students' lack of autonomy, and dominating personalities were cited as potential difficulties to organizing student-led discussion-based tasks. Consequently, teachers believed that teachers need a strong foundation in classroom management and the know-how to set up classroom norms (i.e., pedagogical knowledge—PK). Furthermore, for these teachers, it was difficult to know how to lead productive talk in whole-class settings when they sensed students' general discomfort or when classroom discussions did not fully correspond to what they believed an "ideal" dialogue should look like. During the study workshops, these teachers would later acknowledge that they, like their students, need to develop their competencies as a self-regulated learner. Future research and teacher education programs should continue exploring

how best to reconcile these social and intellectual challenges that teachers are facing or will face when they organize collaborative activities in their classrooms (Butler et al., 2004; Kaendler et al., 2015; Lajoie, 2008).

RQ2: Tacit Factors Influencing Teachers' Change Toward a Dialogic Pedagogy

After initial interviews, teachers met together three times (Workshops 1, 2 and 3) in their respective groups (Groups 1, 2 and 3) to learn about and discuss dialogic pedagogy, collaboration, and metacognition/self-regulation. Each group discussed the challenges and opportunities met while enacting dialogue-intensive pedagogies in their mathematics classrooms. These challenges and opportunities are depicted in an evolving model that reflects the epistemic and action-oriented strategies that teachers use when making pedagogical decisions in the mathematics classroom as well as the (social) factors and (internal/external) intervening conditions that influence whether teachers' pedagogical decisions are indeed dialogic.

Tacit Knowledge and Belief

Teachers' tacit knowledge includes the intuitive strategies, or "tricks of the trade", that they have developed to make split-second decisions when faced with pedagogical dilemmas (Collins & Kapur, 2014; Eraut, 2000; Huberman, 1993). Since many of these strategies have been internalized over years of experience, including teachers' own experiences as students (Darling-Hammond & Bransford, 2005), the challenge then is to develop methods for accessing this intangible knowledge. The pre-workshop interviews, as described earlier, allowed me to access valuable information about teachers' conceptualizations and prior knowledge and beliefs about learning. However, research reveals that different professional contexts (e.g., professional development, classroom practice) can add different levels of authenticity and purpose that

provoke unconscious thought and action (see Brown et al., 1989) which can then be studied through analyses of teachers' situated discourse (see Dudley, 2013; Kelly, 2010).

Observations of teachers' classrooms showed a broad diversity of tacit knowledge and beliefs regarding student-led group work in mathematics, and particularly the introductory and follow-up discussions bookending group work mathematics tasks. Also, teachers' practices were mostly coherent with the way they described their routines during pre-workshop interviews. While this observation contrasted prior research showing that science and EFL teachers' descriptions of their practices are not always aligned with their espoused beliefs of learning (Kagumba, 2015; Kubanyiova, 2015), this observation aligned with one study's finding that mathematics teachers' beliefs are globally coherent with their practices (Stipek et al., 2001). On one hand, these findings suggest that mathematics teachers' tacit beliefs about teaching-and-learning are more categorical. On the other hand, given the unexpectedly high level of teaching expertise of the participating teachers, combined with the high level of motivation expressed by teachers to learn more about dialogue-intensive approaches, leads me to suspect that teachers had gained a certain amount of expertise that was further reinforced by school board PD initiatives and human resource support (e.g., opportunities for team teaching). These support mechanisms could have aided some of the teachers to reflect on, better articulate, and enact more discussion-focused pedagogical knowledge and beliefs well before participating in this study.

I also think that the anonymity of the research, the lack of assessment, and the genuine desire to withhold judgment to better understand teachers' lived experiences and perspectives also ensured that teachers felt comfortable freely expressing their thinking and understanding, which was key to accessing teachers' tacit knowledge and beliefs. Research attests to the importance of creating an environment of mutual trust in which teachers can confront their

beliefs, biases, and weaknesses (Breuleux et al., 2018b; Nelson, 2009; Wall et al., 2011). The most notable example of this occurred when teachers, despite feeling confident in their pedagogical knowledge, did not hesitate to share when they were unsure of the efficacy of a particular strategy that they were using in classrooms. However, I also argue that the full expression of teachers' knowledge and beliefs emerged over the three PD cycles and interviews (i.e., pre-/postintervention interviews, workshops, and classroom experimentation). In line with prior research (Disney, 2016; Sedova et al., 2016), it appeared here that the third and final cycle, was an essential minimum to validate teachers' tacit knowledge and beliefs as well as any change in response to the research intervention.

Tacit Social Factors

Furthermore, and as developed in the emerging model (see Figure 8), *tacit social factors* influenced teachers' pedagogical decision-making. Here, tacit social factors are understood as the social conditions to which teachers unconsciously and repeatedly referred to justify their action (or non-action) in interactional spaces (i.e., classroom discussions, pedagogical discussions during workshops). These factors were similar to the *social capital tools* and some of the affective conditions described by Dudley (2013) when investigating conditions impacting teachers' learning during Lesson Study cycles. The tacit social factors emerging in participating teachers' workshop discourse included the acknowledgment of students' special needs and emotional concerns. Later in the workshops, attending to teachers' feelings of uncertainty (e.g., questioning their own practices, searching viable solutions) was also a non-negligible social condition for teachers' progression throughout the intervention activities.

While analyzing teachers' workshop discourse, it became apparent that these tacit social factors were also intimately connected with teachers' beliefs about their role as a teacher as well

as how they projected themselves as a good teacher. At the outset of the study, navigating the possibilities and challenges in classrooms adapted for students with special needs, specifically students with significant gaps in mathematical content knowledge, caused some initial hesitation and/or skepticism from teachers teaching adapted classes (e.g., Céline, Sylvie). When presented with discursive (verbal) signs indicating that students are engaging in productive dialogue, teachers from each of the groups referred to the nonverbal signs of engagement mentioned during pre-workshop interviews, emphasizing student personality differences (e.g., some students are not as verbal or shy). Relatedly, students' emotional concerns also held a significant place in teachers' responses. In all three groups, these concerns were voiced alongside teachers' perspectives on their role in regulating emotional situations. These interactions were not without tension, as seen in the particularly challenging interpersonal dynamics experienced by two elementary teachers in Group 1 (Sarah, Audrey). Teachers' perspectives revealed subtle but substantial differences. While some teachers believed that the teacher should curtail negative interactions (e.g., group students with peers with whom they get along), others believed that teachers must scaffold dialogic behaviors so that students are ready to work with others (i.e., interpersonal competence building) and understand how to learn together via dialogic classroom norms.

These observations reflect those of Luoto (2020) who identified two starkly different practices while observing and interviewing two Finnish mathematics teachers. One teacher's practice was markedly authoritative, while the other balanced dialogic and authoritative practices. Interestingly, the two focal teachers maintained similar rationales for their practices, focusing on students' learning needs, well-being, and equity. Luoto's (2020) study further highlights how, when teachers believe that it is imperative to be directive and authoritative to

prevent students from getting lost, these beliefs may be founded on teachers' negative lived experiences. In Luoto's study, the teacher whose practices were characterized by an abundance of authoritative talk moves recounts how she had tried discussion-based complex problems with struggling students in the past, but that it was "chaos", only seemingly benefitting high-performing students.

The tacit social factors emerging in teachers' pedagogical discourse show how critical it is for professional development initiatives to be mindful of the belief systems (Buehl & Beck, 2015) that teachers have developed while organizing discussion-rich activities in the past. Workshop facilitators may find that teachers are resistant to dialogic pedagogy if teachers experience or have experienced negative or unproductive classroom interactions (Kilinc et al., 2017). Research further cautions that pedagogical change may be further stunted by deficit models of student ability (Biggs, 1999) which, if deeply seeded in teachers' epistemological beliefs, may further hinder teacher learning and change (Kilinc et al., 2017). Luckily, most of the teachers participating in this study maintained or gradually developed a positive outlook on their students' ability to learn though discussion-rich tasks, even if initially hesitant. Some avenues provided in the intervention helped their initial hesitancy. These are described in the next paragraphs.

Developing a Shared Understanding of Concepts and Vocabulary

The research-based materials and conceptual explanations helped teachers to illuminate, to make sense of, and to re-enact their tacit PK by developing a shared understanding of dialogic concepts and vocabulary about dialogue. For example, workshop materials and activities (e.g., theory on learning through dialogue, guided interaction analyses, example vignettes from prior research) presented teachers with ways to conceptualize and discuss signs of productive dialogue

more concretely, specifically through a shared discourse on productive "dialogue moves" (*Building, Questioning, Challenging, Explaining Reasoning)*. More significantly, teachers carried this discourse throughout the study, implemented it in their classroom practice, and used it to talk about their strengths and weaknesses in their PK and PCK during workshops and post-workshop interviews. In this sense, the shared vocabulary allowed teachers to reflect on their practice in a more intentional way (Georgius, 2013; McAneny, 2013; Scherrer & Stein, 2013; Sezen, 2011), which provoked a more explicit connection between teachers' PK and PCK.

Contingent Support for Teacher Reflection on Tacit Knowledge and Beliefs

Additionally, critical instances of contingent support further aided teachers to put their own tacit PK into question. Consultants, the researcher, and participating teachers provided professional advice to teachers who were facing pedagogical dilemmas and surprises (e.g., unexpected student behavior during discussion-rich tasks), allowing teachers to make connections back to their PK and to project forward to research-informed PCK. As Waymouth (2020) highlighted while exploring concepts of scientific sensemaking with middle school science teachers, reflective discussion activities should ensure that teachers who already possess deep knowledge of collective sensemaking do not take their knowledge for granted, specifically when planning dialogue-rich tasks. Toward this end, it is more likely that the contingent support provided in the workshops allowed discussions to move from "cumulative talk" to "exploratory talk" (Mercer, 2004)—that is, from agreeing and lightly building on one another's ideas to challenging and expanding on one another's understandings. Dudley (2013) posits that these types of critical discussions could allow teachers to access their "tacit knowledge stores" by helping teachers learn to "switch off filters which, since their early careers, have blocked out important elements of daily classroom information" (p. 119). As suggested by teachers in this

study, teachers may also have to "switch off" (a) the belief that teachers must always know what to do, and (b) the fear that uncertainty may provoke judgment and consequently loss of authority (see also Curtis et al., 2020; Lloyd, 2008; McAneny, 2013).

Validation from a school-based expert also proved to be an important factor aiding processes of reflection and change. During workshops, teachers asked questions to compare their knowledge to the researcher's or pedagogical consultant's knowledge. Some teachers even demonstrated instances of unsolicited knowledge sharing, which appeared to be a form of self-validation to presumably indorse their own expertise. During post-workshop interviews, teachers also recounted how they valued the live feedback given by pedagogical consultants during teachers' lessons (e.g., Julie talked about Patricia's "on the spot" feedback) or when observing teachers' lessons (e.g., video recordings show Valérie turning to Sophie to ask a PCK-related question or Sophie modelling a way to explain a specific mathematical concept to students). Fellow expert teachers' feedback was also mentioned as an important and valued addition when pedagogical consultants' support was not present. Based on the progression of the workshop discussions, classroom observations, and teachers' accounts in the post-workshop interviews, expert one-on-one, or personalized contingent support built on teachers' own practice (opposed to vicarious forms of participation) (see Bakkenes et al., 2010), were the most impactful for teachers.

The subject of contingent professional support, or professional scaffolding, is nonetheless challenging. While my own facilitation practices promoted a flexible, open form of contingent support, assumed to be coherent with the dialogic assumptions underpinning this research, the pedagogical consultants' support (Groups 2 and 3) was more directive in nature. Studies have shown that teachers may eventually integrate more flexible discussion-based approaches

through, ironically, procedural implementation and rigid rule following (Heyd-Metzuyanim et al., 2019). However, research also suggests that teachers may superficially implement targeted practice without changing their epistemological beliefs (Wilkinson et al., 2017), which are posited to be an essential element of teachers' learning (Munby, 1984; Nespor, 1987; Richardson, 1996) and daily practice (Buehl & Beck, 2015). Research further cautions us to be mindful of teachers' and other educational leaders' expectations regarding their own and others' learning needs, which may not be aligned with the most up to date understanding of effective learning practices (see, for example, Kirschner, 2017) or may hide other systemic dilemmas (Polojac-Chenoweth, 2020; Wallen & Tormey, 2019). Research should continue investigating ways to empower teachers by providing ways to understand and monitor their own learning processes (Dembo, 2001). Future research involving collaboration with multiple educational stakeholders should also consider having conversations with educational leaders to better understand the expected roles and needs of school boards prior to research participation and how these may inadvertently impact on dialogue-centred approaches (Troiano, 2012; Vedder-Weiss et al., 2020).

Material-Dialogic Affordances of Online Discussions

What's more, the tacit material-dialogic affordances (Cook et al., 2019; Hetherington & Wegerif, 2018; Gibson, 1977) of the workshops and workshop materials steered teachers' collective participation in the workshops, sometimes for more or less effective learning. One noteworthy observation arose early in the workshops and concerned what ought to be deemed a "good" task (i.e., what concrete tasks teachers can use to promote dialogue in mathematics class). The narratives described in the findings depict initial resistance or hesitance, founded principally on teachers' beliefs in their role as a teacher. For some teachers, they found that

workshop discussions justified their current practice (i.e., the status quo). These observations mirror those of Colonis (2011) who found that teachers readily associated discourse-based approaches with their current practice or the current curriculum. Luckily, this study shows that initial hesitancy or resistance is not a be-all-end-all. In fact, closer analysis of teachers' hesitancy suggests that initial episodes of resistance may be a positive sign that teachers are critically engaging with the workshop materials. As a facilitator, I found that my own capacity to respond to this resistance in a dialogic way with dialogue-provoking materials aided workshop discussions. This meant that I acknowledged teachers' agency, encouraged a healthy skepticism, and provided a reasoned approach to confronting classroom challenges, notably with the help of research-based materials that provoked reflection (T-SEDA Collective, 2019). The mutual combination of both material and dialogic facets appeared to be the key to teachers' buy in, even if buy-in was not immediate.

Teachers' ability to recognize the proposed tools and resources in relation to their existing practices also appears to have influenced teachers' adoption, adaptation, or rejection of research-based tasks and tools. This idea goes back to the notion of contingent support that drew on teachers' pre-existing PK to reinforce actionable PCK. A few of the teachers, whether self-directed or encouraged by their pedagogical consultant, found creative ways to adapt the research-based resources to accommodate their existing routines. Indeed, some teachers found it helpful to adapt the research-based materials into new "gambits" for mathematics conversations (see Seymour & Lehrer, 2006). This was evidenced in Valérie's transformation of the dialogic moves *Building* and *Challenging* into "Challenge 1 and Challenge 2" (*le défi 1 et le défi 2*) and Patricia's use of francophone/Quebecois adaptation of classroom norms (i.e., *les 5C des maths*). The concreteness of activities proposed—those presented in the workshops as example vignettes,

those adapted by a participating teacher, or those created from scratch and shared during workshops—had an expansive effect (Engeström & Sannino, 2010) as fellow teachers created a shared vision of tasks (Darling-Hammond et al., 2005) that they could enact in their classrooms to experiment with the conceptual ideas and frameworks presented in the workshops. These tasks changed their routines in the process as teachers began to systematically integrate classroom norms, student dialogue "checklists", and more "dialogic moves" during small group debrief discussions in their classrooms. However, issues of time appeared again, suggesting that dialogue-intensive pedagogies provoke the age-old paradox pitting efficiency against quality inherent in many social research and educational policy debates (Bryman, 2003).

Consequently, the material-dialogic affordances of the student-centred tasks, whether proposed in the workshop or created by teachers or consultants, demand critical reflection on the material-dialogic affordances of workshop activities. This question arose throughout the workshops, particularly in my reflexive memos, on the best ways to create a dialogic space given what could be described as different and sometimes conflicting expectations (e.g., open inquiry approach of research endeavor versus consultants' need to ensure that pertinent information is given). The open inquiry nature of this study appeared to accommodate the expertise of the teachers. Like Vrikki et al. (2021), the guidance prescribed here was arguably less directive than it would have been had the study specifically targeted novice teachers. The workshop materials presented instead dialogic frameworks for making sense of current and future practice rather than pre-made tasks (Fullan, 2001). Waymouth (2020) found as well that experience played a role when teachers explored new instructional philosophies or practices. Although, in Waymouth's study, even a seventh-grade teacher with 14 years of experience expressed needing another 3-5 years before being able to perceive the desired instructional shifts she wants in her practice.

The affordances of the online environment (i.e., video conferencing) to provide the environment necessary for professional dialogue and learning were challenged, as well. Throughout the workshops, the pedagogical consultants noted what they reported to be unexpectedly low teacher engagement compared to their experiences working with some of the teachers during in-person professional development before the pandemic. The consultants acknowledged the multiple opportunities given to teachers to share their thoughts, to elaborate their understanding and to raise critical points, and expressed disappointment when teachers did not immediately respond to researcher-led questions. Only one teacher who was not able to attend the last and final workshop due to scheduling conflicts reported similar expectations as the consultants (i.e., online conversations were not as fluid as in-person discussions).

Regardless initial quietness, teacher verbal participation greatly increased by the third and final workshop. As the researcher-facilitator, I understood that teachers may be initially hesitant to contribute when faced with a new perspective. I also later found out while conducting post-workshop debrief interviews that more than half of the teachers had been taking notes during the workshops which is a significant sign of participation in a PD environment where there are no planned assessments. Teachers also had different expectations about how best to participate in this type of research, which was more exploratory than prescriptive. Teachers gradually contributed more and more to the workshop conversations, probably as they grew more comfortable with their collaborative participant role and experimented with the resources and concepts in their classrooms. Overall, the full three cycles provided a fuller image of teachers' appreciation of and motivation to participate in the workshops, even if the context of schools at the end of the school year appears to be a particular hurdle for teachers and could have affected the third and final classroom implementation for some. Significantly, these observations add

nuances regarding the temporal context (Guskey, 1986; Mercer, 2008; Wallen & Tormey, 2009) to material-dialogic space creation in PD on dialogue-intensive pedagogies.

RQ3: Trajectories of Adopting a More Dialogic Approach in the Mathematics Classroom

Shifting the Focus from Struggling Students to Dialogically Calibrated Practices

It comes as no surprise that teachers would be preoccupied by the socioemotional environment in their classrooms, particularly at the time of the study when students were not able to meet and socialize. However, it appeared that attention to students' emotional and other individual struggles took on greater importance in some teachers' discourse. Teachers' accounts of classroom strategies also reflected at times strong beliefs that teachers' role consists of foreclosing any possible negativity that could arise because of dialogue-intensive practices. Sezen's (2014) study also suggests that tensions in classrooms challenge, and in some cases hinder, teachers' implementation of discourse-rich feedback practices. One teacher in Sezen's study describes the difficulty of engaging students, such as the shy or complacent students (students who are content doing nothing) and then coordinating this lack of engagement with the dominating (although perhaps genuinely interested) voices of other students. Another tension arises when getting students to voice or evaluate one another's views may create a delicate situation if students are perceived as less able or if there is disagreement (Lefstein & Snell, 2018). What's more, attention to students' well-being means that, at times, teachers accept that some students may not be comfortable participating in class discussions, bringing discussion-based practices in tension with the reality of students' social identities as well as different beliefs concerning what it means for teaching practices to be equitable (e.g., allowing all students to participate versus giving all students the necessary structure) (Luoto, 2020).

These concerns may have been partially resolved with the resources provided through the study. Elsewhere in the literature, teachers interviewed were worried that, in implementing student-centred pedagogies including small group work, for example, that students would not remain on task or would foreclose their classmates' learning (Murphy et al., 2018). One teacher recounted how she needed to prevent students from going down "rabbit holes" (Waymouth, 2020). Undoubtedly, teachers do not always know how best to support struggling students in discourse-rich environments. In looking ahead to adopting inquiry-based pedagogy in the future, teachers in Murphy et al.'s (2018) study alluded to the need for "simple, safe and easy" resources, not only to support students' autonomy, but also to prepare them as teachers to manage any new resources available. The authors highlight teachers' tolerance of ambiguity as an important factor in understanding teachers' tacit understanding of inquiry-based pedagogy. It is possible that providing teachers with resources for identifying student dialogue (e.g., checklists, student self-assessments) did just this by clarifying how best to assess potentially productive interactions in the mathematics classroom. It turned out that this type of resource was lacking in teachers' pedagogical repertoire.

It is more likely, however, that teachers more greatly benefitted from simply getting the opportunity to test their understanding of dialogic principles and strategies in their classrooms. This did not require teachers to dramatically change their current practice—indeed, many of the participating teachers were already adept at implementing student-led group work. Rather teachers had to reframe the way they plan and assess dialogue-rich activities. As teachers tried out new strategies (e.g., norms for dialogue, discussion prompts, open questions, more time for students to explain their thinking) and came back to the workshops to discuss questions, challenges, and observations with the other teachers, the notion of struggling students, while not

disappearing altogether, was gradually reframed using vocabulary from the study on dialogic moves (e.g., whether students were building or challenging one another) and critical discussions ensued focusing on teachers' own capacity to encourage and identify productive dialogue. While some of the questions raised remained in suspense at the end of the workshops (e.g., whether and how to reward students' unproductive struggle, how to manage time when discussion-based tasks last longer than expected), post-workshop interviews revealed that teachers managed nonetheless to gain a greater personal sense of their role in ensuring that productive dialogue emerges in their classrooms. These processes were arguably supported by participating teachers' pre-existing pedagogical knowledge, external support mechanisms (e.g., school board cultures that encourage discussion-based approaches), and the dialogic space provided for teachers to discuss their questions, challenges, and opportunities as they tried out different discussion-based strategies. Consequently, mathematics teachers' conceptualization of learning through dialogue shifted—if ever so slightly—toward a more collective view of learning, as evidenced in teachers' intuitive pre-post intervention descriptions of dialogue.

Furthermore, it was conjectured that the second half of the workshop materials, highlighting metacognition and self-regulation, provided teachers with the necessary complementary framework needed to reconcile dialogue with their own hesitations about providing more opportunities for student-led talk, by reminding and reassuring teachers that struggle, even in groups, can be productive if situated in a dialogic-metacognitive space. I argue that this conceptualization illuminates an essential dimension to the dialogic-monologic dichotomy increasingly seen as limiting our understanding of teachers' curricular goals and pedagogical strategies for reaching them. As the literature suggests, the monologic-dialogic

binary is insufficient for accounting for all types of dialogical interactions (see Bomphray, 2018; Mortimer & Scott, 2003). Future studies should continue exploring these ideas.

Outcomes on Teacher Practice

Thanks to workshop discussions, teachers managed to adopt what they would describe during post-workshop interviews (Interview 2) as helpful perspectives on what makes dialogue productive, provided that the proper pedagogical knowledge and support mechanisms were in place. Most of the teachers (n = 7) self-reported that they refreshed existing pedagogical knowledge, while becoming more critical of their approach to classroom dialogue. Waymouth (2020) found as well that teachers, and particularly the most experienced, did not experience dramatic changes to their conceptualizations as a result of the intervention due to pre-existing knowledge and beliefs that were simply confirmed during the intervention.

Teachers also reported moderate changes to their teaching practices more broadly. While these conservative changes may seem menial, when compared to prior research on experienced teacher learning, moderate learning over such a small period of time (i.e., four-month research design) is quite substantial when compared to the rare changes reported in Bakkenes et al.'s (2010) year-long study. Bakkenes et al.'s conjecture that more time is required before seeing change in practice was not the case in this sample of teachers. The recordings that teachers provided of their classroom practice allowed us to confirm these reports. Given that Bakkenes et al.'s study focused primarily on active and self-regulated learning, it is possible that teacher learning benefits from the combined dialogic and metacognitive goals that, in prior research, have been shown to create a more effective learning space for children's development of mathematical understanding than either dialogic or metacognitive goals on their own (Howe, 2013; Kramarski, 2004; Mercer et al., 2006; Meverech & Kramarski, 1997; Sengupta-Irving &

Agarwal, 2017; Slavin et al., 2009; Taylor & Cox, 1997; Webb & Mastergeorge, 2003). Future research could test this hypothesis using an experimental design.

Despite teachers' accounts of mitigated change, surprising moments of classroom dialogue occurred that may not have been fully apprehensible while teachers were in the thick of teaching. Consequently, teachers may not realize when productive moments of dialogue occur, or they may maintain unrealistically high expectations of student dialogue (McAneny, 2013). For example, Sophie encouraged Valérie to view "challenging" not as a specific phrase like "I challenge you", but rather a panoply of questioning and shared confusion, spontaneously raised by students as they get more comfortable working in small groups. Additionally, the development of dialogue may not occur in a linear path. This applies to teachers as well. Teachers' facilitation of dialogic interactions (i.e., dialogic moves) (Hennessy et al., 2020) were observed fluctuating from one recorded lesson to the next. Research associates these fluctuations with the necessary time that teachers need to "grapple" with new practices and to "consolidate changes in routine practices" (Davies et al., 2017, p. 980). It is also possible that teachers' dialogic practices were affected by the end-of-the-year rush when the third and final classroom recordings took place. More recent research suggests, however, that certain elements of dialogue may decrease in frequency as shared signs of practice are internalized (Beck et al., 2022).

In contrast to teachers' mitigated changes to practice, teachers reported significant changes to their pedagogical positioning when facilitating math discussions. Six teachers gave specific descriptions of changes they now make when organizing dialogue-rich tasks (e.g., adopting a "researcher's eye" to better evaluate the cause and effect of classroom talk). Others, while initially skeptical of small-group activities (e.g., Caroline's narrative), are now convinced that they are effective environments for learning in the mathematics classroom. Participants

attributed most of the changes that they experienced with their participation in the research project, which was further supported by teachers' motivation at the outset of the study. The significant positive changes observed in student interactions also proved to be critical to teachers' adoption of more dialogic approaches. Furthermore, most of the teachers plan on using the resources, tools or ideas learned in their future pedagogical activity, an observation that was also remarked by Bakkenes et al. (2010).

Although the study was not evaluative in nature—again, the goal was not to assess teachers' knowledge through a standardized test and, as Bakkenes et al. (2010) point out, is arguably an ineffective way to evaluate experienced teacher learning—any change in teachers' intuitive descriptions of dialogue were nonetheless considered to be potential indicators of learning (see also Davies et al., 2017). After participating in the study, teachers' descriptions shifted toward broader, conceptual descriptions. It could be said that teachers' post-workshop descriptions reflect a deeper, more far-reaching understanding of dialogue compared to their initial conceptualizations. While teachers' descriptions in Interview 1 centred principally on exchanges between students, teachers' definitions in post-workshop interviews reflect the idea that dialogue concerns everyone, not just students.

Teachers' outcome-oriented descriptions also provide a telling case of a shift in teachers' understanding of what makes dialogue productive. Teachers initially focused on individual performance aspects of group work (e.g., individual achievement); by the end of the study, teachers shifted their focus to group understanding (e.g., everyone in the group can understand). Also, at the beginning of the study, only a few teachers identified argumentation (e.g., challenging, questioning) as a sign of productive dialogue; during post-workshop interviews, five

additional teachers mentioned the importance of challenging and questioning to productive dialogue in mathematics.

Teachers expanded research-based perspectives on argumentation discourse with their own experiences. Specifically, teachers were mindful of the social tensions that may arise when students voice their disagreement with a peer's idea (see Snell & Lefstein, 2018). Most of the teachers' responses suggest that they learned that this tension was a necessary feature of productive dialogue, but one that should not be left to chance (McAneny, 2013; Waymouth, 2020). Further evidence emerged in support of this idea, such that, when compared with pre-workshop interviews, teachers relied less on instances of nonverbal cues as signs of productive dialogue. Teachers referenced instead specific examples of open questions and coordination strategies that they as teachers can use to create more equitable dialogic spaces that encourage students to be more comfortable verbalizing their thinking in whole-class settings and working collaboratively in small-group settings. With the exception of one teacher, the other nine teachers recounted how participating in the study helped them to focus on the alignment between mathematical goals, discussion-rich tasks, and teachers' dialogic moves.

In this study, the opportunity to see one's classroom as if from the outside encouraged teachers to critically reflect on their own practice. This "outside" perspective emerged by way of different affordances, specifically participation in the research study, collaborating with pedagogical consultants, and supervising student teachers. The study parameters, in encouraging teachers to adopt a dialogic approach, encouraged teachers to experiment with small-group tasks and open questions ("dialogic moves"). Three teachers, each from different groups, spoke specifically about the study as if it gave them permission to try out peer-led activities without worrying that symmetrical interactions (Fernández et al., 2001) might impede learning.

Experimentations allowed these teachers to observe positive instances of peer-led activity which, for two of these teachers (Sarah, Cindy), meant that they were encouraged to persevere despite the difficulties met.

Challenges and Opportunities of Collaborative Online Reflection

For as long as educational institutions have existed, educators have tackled how best to capitalize on technological advances to ostensibly promote better, more individualized opportunities to learn (see Cuban,1984; Papert, 1980). Since the late 20th century, the global explosion of information access via the World Wide Web, including access to mobile devices with high-speed Internet and extended capabilities to search, share, create and communicate, have changed the way we envision learning spaces, including the provision of collaborative environments responding to constructivist ideals of learning based principally on the idea that learning is not solely an individual enterprise. The flexibility offered by these information and communication technologies have certainly had their appeal over the years and have been the object of much reflection and research (Baron et al., 2013; Breuleux et al., 2009; Laferrière et al., 2007). However, notions of progress for learning with digital technologies have continually met roadblocks at both the individual and systemic levels (Cuban, 1998). At their core, many of these roadblocks are not new dilemmas (see Cuban, 1984) but rather new manifestations of old problems rehashed with digital undercurrents. It is thus imperative that researchers, educators, and educational stakeholders maintain a critical stance as we attempt to better understand the affordances and even the contradictions inherent in new collaborative online spaces.

Whether in-person or online, reflection is a key element in learning processes. However, reflection is challenging, and reflecting with others brings on a load of complex social issues to consider. One illuminating example arose when one teacher recounted how it was difficult for

her to put into question the discussion-based routines that she had developed over the years and that she grew to be proud of. Another teacher recounted how she initially felt intimidated to be meeting with two teachers whom she knew from her experience to have been in the school board for a long time. This comment stood out to me given how the two expert teachers she mentioned interacted during the workshops. For example, one of these teachers seemed to look for opportunities to demonstrate her competence. In contrast, the other teacher realized how her own confidence might foreclose students' confidence during classroom discussions. I argue that these personality dynamics could have created additional barriers to less expert teachers' learning had they not been hedged by the more expert teachers' willingness to admit areas that they too can work on and to demonstrate a genuine willingness to help their fellow teachers progress in their practice. Admittedly, this was not a solution for every teacher—particularly for one teacher who found it difficult to understand why all experienced teachers were not already implementing dialogic practices. Social complexities including individuals' motives for how and when to verbalize their thoughts, organizational or mandated roles of participating members, and expectations of authority and expertise further proved to complicate collective reflection.

These types of face-saving behaviors have been reported in previous research (Males et al., 2010; Waymouth, 2020) and present genuine issues for PD programs that wish to leverage learning through collaborative experiences, whether in online or in-person settings. These challenging episodes reveal that, like students, teachers have not always had opportunities to live and work through the tension or contradictions experienced in classrooms. Here, I found the concept of *perezhivanie* to be pertinent. In Russian, *perezhivanie* conveys that moment when people "live" (*zhivat*) or endure difficulty and let it "pass beneath […] overleaping it" (*pere*) (Blunden, 2016). In this study, the concern was not only that some teachers may experience

difficulties in their classrooms, but that their professional environment may not always allow them to "overleap" these difficulties and adequately "process" what they are coping with (Blunden, 2016). One pedagogical consultant in this study even showed signs of foreclosing this professional tension, suggesting that teachers may not be able or willing to engage with one of the math-based reflective discussion activities chosen for the workshops. This expression of perceived ability and motivation subsequently had an impact on the choice of activities proposed in the workshops as well as the way that consultants talked about mathematics (or not) during the discussions. Thus, research should continue investigating ways to help teachers and educational leaders develop the capacity to engage in productive professional dialogue, as begun in research on Lesson Study (Widjaja et al., 2017) in research-practice partnerships (Breuleux et al., 2018b).

Similar to Chee et al.'s (2015) observation, the online components were not so much a barrier to teaching learning as the dialogic pedagogy underpinning the online activities. Technical issues may, however, exacerbate complex social spaces if they are perceived as interrupting or hindering "natural" interactions, as was perceived by one teacher in this study. Furthermore, the combination of external stressors created a barrier for one teacher who found it challenging to reconcile the dialogic philosophy explored in the study with the reality of her classroom experiences (e.g., uncontrollable interpersonal complications between students, catching up on math content after repeated class shutdowns due to the pandemic). Despite the difficulties experienced, teachers expressed a desire to keep challenging themselves through more research participation and even more advanced pedagogical formats (e.g., collaborative curriculum design). This observation speaks to the potential for dialogic pedagogy and dialogue-intensive approaches more broadly to encourage teachers to persevere despite difficulties or initial hesitancies.

Overall, collaborating with other teachers and educational experts came with its pros and cons. Teachers greatly appreciated being able to meet with other teachers, to share different perspectives, and to compare practices in different schools or different grades. For one Grade 5 teacher, meeting with Grade 6 teachers allowed her to get a glimpse into where her students will be going the next year. Meeting with other teachers also greatly benefitted the participants on a social level (e.g., prevent feeling of isolation). As seen earlier, one teacher spoke of the difficulty interacting with teachers when attending high volume online meetings (50+ attendees). Another teacher shared how she appreciated how the study allowed the teachers to talk about pedagogy, which is not always possible, particularly when administrative duties (e.g., assemblies, committee meetings, parent meetings) encroach upon teachers' pedagogical days.

Expanding Learning Beyond the Workshops and Classrooms

Furthermore, teachers experienced surprising learning moments. Teachers across all three groups witnessed unexpected changes to their students' group behaviors. In particular, teachers reported that they witnessed boys participating in productive talk and demonstrating greater comfort talking in groups and learning through discussion-rich tasks. Céline also noticed how her Grade 8 students began self-selecting team members based on how well they could work together rather than on affinity. Teachers also expanded the sphere of influence of the study material, referencing their personal life and their professional decisions. In coherence with a dialogic philosophy, Valérie shared how she guided mathematic discussions with her daughter and observed the budding of learning above and beyond her daughter's curricular capacity (3rd grade daughter understanding the concept of negative integers). Cindy and Mélissa recounted how they now use building and challenging in their team-teaching conversations. Sylvie shared how she signed up to have a teacher intern, an idea that she had been strongly opposed to before

participating in the study. She realized that she had something to offer others. In the end, one might say that these experiences represented a type of *perezhivanie* for these teachers.

In some ways, these findings go well beyond Howe and Mercer's (2017) conjectures of the processes by which teachers adopt dialogic teaching. It is possible that this group of teachers, having close links with pedagogy adapted to students with learning difficulties, had already developed what Darling-Hammond et al. (2005) refer to as a "curricular vision" for their practice that included a broader panorama of adaptive practices, including discussion-based approaches arguably more akin to quasi-dialogic practices. Teachers did reveal instances of appropriating dialogic teaching while maintaining a certain amount of alignment with pre-existing pedagogical practices. However, teachers' existing expertise and arguably their motivation to learn at the outset of the study proved to positively influence most of the teachers' learning beyond simple adoption, even in a subject-matter like mathematics known for its adherence to strict disciplinary norms. Instead, teachers were curious to learn more about dialogue-intensive pedagogies and strategies. The research-based activities in parallel with classroom practice appeared to have strengthened teachers' curricular vision and allowed teachers to not only calibrate their practices based on a more structured vision of dialogic pedagogy (Howe & Mercer, 2017), but also to provide teachers with tools (not just material but also material-dialogic tools) needed to critically assess their own practice.

Comparing the Emergent Model to Existing Models of Teacher Learning

The emergent findings support in non-negligible ways some of the assumptions underpinning theories of teacher learning, and not just in terms of tacit factors. For this reason alone, the findings of this study are important. Specifically, the model reaffirms the close link between teachers' tacit knowledge and beliefs (Collins & Kapur, 2014), and these were shown to

be intimately linked to teachers' authentic pedagogical activity in classrooms (Brown et al., 1989). Reflection and action also proved to be inseparable teacher learning activities (Dewey, 1933; Schön, 1983, 1987; Freire, 1970, 1973), mutually supporting one another in non-linear, iterative cycles of practice-based (Korthagen, 2017) mediated social activity.

Similar to Sedova et al.'s (2016) study—inspired by Korthagen's action-provokes-reflection model—contextualization, that is teachers' lived experiences in the classroom (including students' uptake of reasoning moves), affect subsequent teacher change. While reflection was equally as important, they suggest that sequencing, or phasing, played a role in allowing teachers to adopt approaches in incremental steps and then to subsequently reflect on them. Thus, change appears to happen gradually (or partially) in tandem with these phases.

Additionally, the emergent model adds essential nuances to models of teacher learning proposed in prior research on teacher learning processes. The model expands conceptualization of teacher learning by revealing the importance of tacit social factors and the material-dialogic affordances of tasks in actively influencing teachers' "personal domain" and "domain of practice" (Clarke & Hollingsworth, 2002). This observation encourages future research to consider the context, or "change environment" not as a backdrop (as depicted in Clarke and Hollingsworth's model) but as an essential category, as depicted in Vermunt and Endedijk's (2011) model.

Furthermore, the emergent model provides an added benefit to others that have ventured to capture both the overt and covert dimensions of teacher learning processes (see Vermunt & Endedijk, 2011). Specifically, the emergent model provides access to specific tacit factors that influence and, in some cases, mediate mathematics teachers' meaning making processes while learning about dialogic pedagogy. Vermunt and Endedijk (2011) argued that investigating

pedagogy-specific learning processes is an essential step toward understanding teacher learning more broadly. The model also provides directionality in between tacit factors underpinning teacher learning processes. This is an important advancement in knowledge as it provides testable hypotheses for future research on teacher learning (see Warwick et al., 2016).

In partial support of Warwick et al.'s (2016) conceptualizations of teacher learning of dialogic pedagogy, the dialogic space created in collective reflection were undeniably important. However, this study challenges the assumption that collective reflection is necessarily/always beneficial. Warwick et al. rightly cite Perry and Lewis' (2009) "cautionary tale" that lack of guidance in early stages of lesson study created disparate learning results (Warwick et al., 2016, p. 558). What is the role of expertise in these cycles of reflection? How do facilitators ensure that a dialogic space is created? At the time when this study's data were being analyzed and synthesized, new research was simultaneously emerging investigating these questions (see Hennessy et al., 2021). Thus, research suggests that these questions are timely.

Limitations

In qualitative research, small sample sizes (i.e., under 20 participants) are not inherently problematic (Braun & Clarke, 2013). However, it should be acknowledged that, given the wide readership of educational research, a bias nonetheless leans toward sizable samples (i.e., at least 30 participants) (Thomson, 2010). Arguments in favor of larger sample sizes are reasonably built on concerns of credibility (i.e., validity) and transferability (i.e., generalizability) (Cronbach, 1975). These critiques are often reasonably founded in observations of over-generalized conclusions founded on a limited number of vague themes (Charmaz, 2006; Morse et al., 2021). Nonetheless, I argue that small numbers, while inherently perceived as a limitation, can be a powerful source of knowledge if greater depth is sought through micro-analytic methods, as

implemented in this study. Inevitably, a large number of participants, while providing a greater base of perspectives, is no less at risk of cherry picking if the resources provided for analytical procedures cannot keep up with the sheer volume of participant responses (Morse, 2000).

Despite arguments in favor or against small sample sizes, the question of transferability remains: to what extent does this research have contextual transferability beyond the very specific research parameters described? Indeed, the question of teacher learning was investigated within the context of online professional development, and particularly taking place within the context of the global COVID-19 pandemic (e.g., frequent school closures, physical distancing limiting dialogic practices, general uncertainty about classroom conditions). While teachers' responses revealed a reasonable level of comfort operating in an online environment, especially after almost a full year of instructing in online environments due to the pandemic, researchers must thus take these parameters in careful consideration when interpreting findings. For example, one teacher shared how she found it to be more difficult to have a fluid conversation in the online context. These concerns will be the object of future investigations.

Investigations of teacher learning took place in Quebec with teachers from linguistically different cultures—an English-speaking school board and a French-speaking school board. However, the interpretations given here are not meant to illuminate differences based on these linguistic differences. As described in more detail in the methodology section, different support mechanisms were provided in the French-speaking school board (e.g., pedagogical consultant support, school board support of classroom recordings). For these reasons, the two school board experiences are not comparable on the linguistic feature alone.

While grounded theory privileges theoretical sampling (Corbin & Strauss, 1990), research in educational contexts raise nonetheless the question of whether the sample is

representative of the population, here mathematics teachers in late elementary/early secondary in Quebec. There are currently nine English-speaking school boards compared to 60 French-speaking school boards in Quebec (Ministère de l'Éducation, 2022). These figures give legitimacy to the proportionally higher number of French-speaking teachers participating in this study. However, the findings are by no means expected to represent all the experiences and perspectives of late primary/early secondary mathematics teachers in Quebec. This research gives emergent findings for future research to continue growing knowledge on the factors that influence mathematics teachers' learning in Quebec, specifically when learning about dialogue-intensive pedagogies.

Chapter 6: Conclusions

The Future of Dialogic Pedagogy

Dialogic pedagogy essentially challenges our understanding of what it means to learn. Learning is not simply the acquisition of new knowledge, but a conversation in which we share, reflect, respond to, challenge, and use our collectively built knowledge to create social environments in which we can thrive together. Teachers can promote such environments in classrooms, but teachers also need to be supported to learn how to create and sustain productive, dialogic environments. In coherence with a dialogically framed paradigm of learning, Fullan (2001) suggests that "[r]esearch findings on the change process should be used less as instruments of 'application' and more as means of helping practitioners and planners 'make sense' of planning, implementation strategies, and monitoring" (p. 32).

These points raise non-negligible issues concerning the capacity of school systems and educational partnerships to provide environments that promote agentic, sustainable change (Fullan, 2001). These environments do not only include the professional support provided, such as access to professional development initiatives, resources, or technologies (see Clarke & Hollingsworth, 2002); agency-building environments also include the school culture (e.g., importance of collaborative curriculum design activities) and the language used about teacher learning activities. Newberry and Richardson (2015) found that the metaphors used by teachers to describe their partnership activities with a university revealed mismatches and possible hindrances to collaborative partnership activities, not only seen in the way teachers positioned themselves, but also in the way they positioned others. To further complicate matters, Newberry and Richardson found that lack of teacher voice and 'buy in' and 'border politics' was largely masked by passive compliance. Vedder-Weiss et al. (2020) also demonstrated how vies for

leadership and authority manifested themselves in often unexpected ways, resulting in several dilemmas as the research team tried to make sense of the intra- and interpersonal conflicts they were witnessing throughout the project. The authors recount how different actors negotiated their roles in the RPP, showing signs of "creative non-compliance", autonomy-seeking goals, as well as what could be considered rogue projects initiated by independent members with, at times, ulterior motives not readily obvious to other RPP members. Troiano (2012) too had to find a way to respect and negotiate converging and diverging perspectives between researcher and teachers.

Again, teacher learning is complex. To ensure that classrooms are providing students with the educational dialogues necessary for their social and cognitive development, research and educational organizations must continue exploring ways to provide agency-building environments in which educational systems, including administrators, researchers, and teachers, are supported to critically investigate their assumptions of what dialogue entails for schools and teaching-and-learning activities.

Recommendations for Future Research

Explaining Fluctuations in Teachers' Classroom Discourse Moves

As seen in this study, teachers' development was not linear. In fact, for some teachers, there were fluctuations in teachers' dialogic practices, resulting in incremental changes for some, while for others dialogic practices improved from Time 1 to Time 2 but appeared to regress by Time 3. For reasons of scope, these questions remained in suspense by the end of this study; however, this appears to be a recurrent observation during teachers' development of dialogue-intensive pedagogies, as evidenced in similar observations in other studies (Davies et al., 2017; Kilinc et al., 2017; Sedova et al., 2016). A follow-up case study is currently under investigation to shed light on these tendencies and possible explanations for their occurrence.

Online Versus In-Person Professional Development

With access to digital technologies and online resources readily available to many professionals in Quebec, research should continue exploring the best ways to leverage teacher learning through online professional development spaces. However, the accessibility of stable Internet connections and materials to facilitate online workshops cannot be taken for granted. For instance, there were moments during this study when conversations revealed the difficulty met by some teachers to procure adequate technologies or to even access quiet and calm rooms where they could focus on their professional development activities.

Furthermore, research should also investigate the degree to which certain activities are best reserved for specific formats (online, in-person, or blended). The material-dialogic affordances of online spaces posed some challenges in this study (e.g., types of interactions afforded by online discussions). Thus, research could expand this question by investigating the type of professional activities on dialogic pedagogy are better suited for in-person professional development.

Training Novice Teachers

This study did not specifically address novice teacher learning. Furthermore, research participation in studies on dialogue-intensive pedagogies suggest that research may self-censure participation from novice practitioners if the recruitment procedures are not carefully planned. Specifically, research projects may appear to cater to more expert teachers, especially if the study parameters ask teachers to discuss their former teaching experiences or to film their classroom practice. These activities may intimidate early-career teachers or may be deemed premature for early career teachers. For example, teachers may feel the need to figure out their class, before tackling what may amount to for some teachers as philosophical directions best reserved for

veteran teachers. While novice teachers' hesitations are understandable, these concerns warrant a closer look at student teachers' sense-making processes while learning about dialogue-intensive pedagogies, not only during early years of teacher training, but even as early as their first years in general education courses. Some might argue that the earlier that future teachers are exposed to dialogic principles, the less likely that monologic mindsets or habits emerge or persist.

The Expert Voice in Dialogic Pedagogy

More experienced teachers and consultants in this study helped teachers to reflect not only on their pedagogical stance more broadly, but also on its application in the mathematics classroom. I believe that this occurred by ensuring that teachers' lived experiences, and in some cases very difficult and complex situations, were heard and acknowledged. The workshop discussions respected these lived experiences while also giving teachers research-based alternatives for concretizing a dialogic–metacognitive space. For example, these alternatives included strategies for establishing dialogic classroom norms, scaffolding tips for small-group activities, and planning/goal setting principles for tasks that target collaborative–metacognitive behaviors. Again, the pedagogical consultants' role was key in these instances, particularly when providing personalized feedback and constructive criticism so that teachers may continually grow toward mathematically productive dialogue and its realistic assessment in curricular contexts. Yet, when pedagogical consultants were not present or were not verbal about specific points, the more experienced teachers within the group also played an important role in sharing pedagogical knowledge.

Research suggests that both veteran and novice teachers benefit from expert feedback. Cheng et al. (2015) describe two Chinese teachers' (one early career and one expert teacher) as they adopt Collaborative Reasoning (CR) approaches. The authors describe their learning

trajectory, going from feeling lost to gaining the capacity to regularly implement the discussion-based strategies. These transitions were aided by a personalized local CR coach who assisted teachers' planning and reflection. Hoekstra and Korthagen (2011) also suggest that personalized coaching practices that focus on teachers' beliefs and core values were instrumental in influencing productive reflection and change in behavior of one veteran teacher. However, this perspective raises the question regarding who is deemed an expert in professional development initiatives on dialogic pedagogy and other dialogue-intensive practices. Indeed, the way expertise is framed and conveyed, including the underlying roles of different stakeholders, may influence the progression of teacher learning of dialogic pedagogy in subject-specific areas (see Hennessy et al., 2011). These directions merit further reflection and investigation.

Final Concluding Remarks

The rich findings presented in this study invite us into a thought-provoking conversation about education and learning that certainly hold potential for a wealth of future research directions. Thanks to the collaborative work with passionate teachers and pedagogical consultants who have generously contributed to research like this one, in-depth analyses of multiple forms of pedagogical discourse may further aid our understanding of teacher learning toward more dialogic approaches and pedagogies. While these perspectives are key to better understanding the multi-faceted processes of teacher learning, they also present new questions to explore. As Bakhtin (1986) wrote, "If an answer does not give rise to a new question from itself, it falls out of the dialogue" (p. 168). It is my hope, then, that this dissertation gives rise to new questions as fertile ground for more dialogues yet to come.

References

Akkerman, S. F., & Bakker, A. (2011). Boundary crossing and boundary objects. *Review of Educational Research*, *81*(2), 132–169. https://doi.org/10.3102/0034654311404435

Alexander, R. (2008). Culture, dialogue and learning: Notes on an emerging pedagogy. In N. Mercer & S. Hodgkinson (Eds.), *Exploring talk in school: Inspired by the work of Douglas Barnes* (pp. 91–114). SAGE Publications Ltd. https://doi.org/10.4135/9781446279526

Alexander, R. J. (2001). *Culture and pedagogy: International comparisons in primary education*. Blackwell.

Alexander, R. J. (2004). *Towards dialogic teaching: Rethinking classroom talk* (2nd ed.). Dialogos.

Anderson, C. W., de los Santos, E. X., Bodbyl, S., Covitt, B. A., Edwards, K. D., Hancock II, J. B., Lin, Q., Morrison Thomas, C., Penuel, W. R., & Welch, M. M. (2018). Designing educational systems to support enactment of the Next Generation Science Standards. *Journal of Research in Science Teaching*, *55*(7), 1026–1052. https://doi.org/10.1002/tea.21484

Argyris, C. (1976). Theories of action that inhibit individual learning. *American Psychologist*, *31*(9), 638.

Aronson, E. (1978). *The jigsaw classroom*. Sage.

Artz, A. F., & Armour-Thomas, E. (1992). Development of a cognitive-metacognitive framework for protocol analysis of mathematical problem solving in small groups. *Cognition and Instruction*, *9*(2), 137–175. https://doi.org/10.1207/s1532690xci0902_3

Ashley, L. M. (2016). *Implementation of a math workshop model in the elementary classroom: Understanding how teachers differentiate instruction.* (Publication No. 10094617) [Doctoral dissertation, Northeastern University]. ProQuest Dissertations and Theses Global.

Aşık, A., & Kuru Gönen, S. İ. (2016). Pre-service EFL teachers' reported perceptions of their development through SETT experience. *Classroom Discourse*, *7*(2), 164–183. https://doi.org/10.1080/19463014.2016.1150865

Asterhan, C. S. C., Howe, C., Lefstein, A., Matusov, E., & Reznitskaya, A. (2020). Controversies and consensus in research on dialogic teaching and learning. *Dialogic Pedagogy: An International Online Journal*, *8*. https://doi.org/10.5195/dpj.2020.312

Bae, C. L., Mills, D. C., Zhang, F., Sealy, M., Cabrera, L., & Sea, M. (2021). A systematic review of science discourse in K–12 urban classrooms in the United States: Accounting for individual, collective, and contextual factors. *Review of Educational Research*, *91*(6), 831–877. https://doi.org/10.3102/00346543211042415

Baines, E., Rubie-Davies, C., & Blatchford, P. (2009). Improving pupil group work interaction and dialogue in primary classrooms: Results from a year-long intervention study. *Cambridge Journal of Education*, *39*(1), 95–117. https://doi.org/10.1080/03057640802701960

Baker, M. J. (2020). Types of types of educational dialogue. *Learning, Culture and Social Interaction*, Article 100387. https://doi.org/10.1016/j.lcsi.2020.100387

Bakhtin, M. M. (1981). *The dialogic imagination: Four essays* (M. Holquist, Ed.; C. Emerson & M. Holquist, Trans.). University of Texas Press.

Bakhtin, M. M. (1986). *Speech genres and other late essays* (M. Holquist & C. Emerson, Eds.; V. McGee, Trans.; 1st ed.). University of Texas Press.

Bakkenes, I., Vermunt, J. D., & Wubbels, T. (2010). Teacher learning in the context of educational innovation: Learning activities and learning outcomes of experienced teachers. *Learning and Instruction*, *20*(6), 533–548. https://doi.org/10.1016/j.learninstruc.2009.09.001

Bakker, A. (2018). *Design research in education: A practical guide for early career researchers*. Routledge.

Bakker, A., Smit, J., & Wegerif, R. (2015). Scaffolding and dialogic teaching in mathematics education: Introduction and review. *ZDM*, *47*(7), 1047–1065. https://doi.org/10.1007/s11858-015-0738-8

Ball, D. L., Thames, M. H., & Phelps, G. (2008). Content knowledge for teaching: What makes it special? *Journal of Teacher Education*, *59*(5), 389–407. https://doi.org/10.1177/0022487108324554

Barab, S. (2014). Design-based research: A methodological toolkit for engineering change. In R. K. Sawyer (Ed.), *The Cambridge handbook of the learning sciences* (2nd ed.). Cambridge University Press. https://doi.org/10.1017/CBO9781139519526

Barab, S., & Squire, K. (2004). Design-based research: Putting a stake in the ground. *Journal of the Learning Sciences*, *13*(1), 1–14. https://doi.org/10.1207/s15327809jls1301_1

Barnes, D. (1976). *From communication to curriculum*. Penguin Books.

Baron, G.-L., Bruillard, É., & Barrère, A. (2013). École et dispositifs technologiques : Points de vue croisés. *Carrefours de l'education*, *36*(2), 117–129. https://doi.org/10.3917/cdle.036.0117

Barron, B. (2003). When smart groups fail. *Journal of the Learning Sciences*, *12*(3), 307–359. https://doi.org/10.1207/S15327809JLS1203_1

Barth-Cohen, L. A., Smith, M. K., Capps, D. K., Lewin, J. D., Shemwell, J. T., & Stetzer, M. R. (2016). What are middle school students talking about during clicker questions? Characterizing small-group conversations mediated by classroom response systems. *Journal of Science Education and Technology*, *25*(1), 50–61. https://doi.org/10.1007/s10956-015-9576-2

Beck, S. J. (2022, April 22). *Exploring meaningfulness and teacher agency development in a research-practice partnership* [Paper presentation]. Annual Meeting of the American Educational Research Association (AERA), San Diego, California, United States.

Berkovich, I. (2016). Pedagogy out of order: Relinking critical teaching with the dialogical aspect of transformative learning. *Teachers College Record*, Article 19453. http://www.tcrecord.org/Content.asp?ContentID=19453

Berliner, D. C. (2006). Educational psychology: Searching for essence throughout a century of influence. In P. A. Alexander & P. H. Winne (Eds.), *Handbook of educational psychology* (2nd ed., pp. 3–42). Erlbaum.

Biggs, J. (1996). Enhancing teaching through constructive alignment. *Higher Education*, *32*(3), 347–364. https://doi.org/10.1007/BF00138871

Biggs, J. (1999). What the student does: Teaching for enhanced learning. *Higher Education Research & Development*, *18*(1), 57–75. https://doi.org/10.1080/0729436990180105

Billett, S. (1996). Towards a model of workplace learning: The learning curriculum. *Studies in Continuing Education*, *18*(1), 43–58. https://doi.org/10.1080/0158037960180103

Billett, S. (2002). Critiquing workplace learning discourses: Participation and continuity at work. *Studies in the Education of Adults*, *34*(1), 56–67. https://doi.org/10.1080/02660830.2002.11661461

Blackburn, J. (2000). Understanding Paulo Freire: Reflections on the origins, concepts, and possible pitfalls of his educational approach. *Community Development Journal*, *35*(1), 9–15. https://doi.org/10.1093/cdj/35.1.3

Bloomfield, E. C. (2016). *Dialogic learning and self-explanation in classrooms implementing worked example instruction with interactive whiteboard technology* (Publication No. 10306908) [Doctoral dissertation, University of Kentucky]. ProQuest Dissertations and Theses Global.

Blumer, H. (1969). *Symbolic interactionism: Perspectives and methods*. Prentice Hall.

Blunden, A. (2016). Translating *perezhivanie* into English. *Mind, Culture, and Activity*, *23*(4), 274–283. https://doi.org/10.1080/10749039.2016.1186193

Boland, R. J., Jr., & Tenkasi, R. V. (1995). Perspective making and perspective taking in communities of knowing. *Organization Science*, *6*(4), 350–372. https://doi.org/10.1287/orsc.6.4.350

Bomphray, A. R. (2018). *"Discussion is the laboratory": A cross-comparative analysis of four secondary ELA teachers' discussion-leading practices* (Publication No. 11006854) [Doctoral dissertation, University of Michigan]. ProQuest Dissertations and Theses Global.

Borko, H., Zaccarelli, F. G., Reigh, E., & Osborne, J. (2021). Teacher facilitation of elementary science discourse after a professional development initiative. *The Elementary School Journal*, *121*(4), 561–585. https://doi.org/10.1086/714082

Boschman, F., McKenney, S., Pieters, J., & Voogt, J. (2016). Exploring the role of content knowledge in teacher design conversations: Content knowledge in teacher design talk. *Journal of Computer Assisted Learning*, *32*(2), 157–169. https://doi.org/10.1111/jcal.12124

Boyd, M. P., & Markarian, W. C. (2011). Dialogic teaching: Talk in service of a dialogic stance. *Language and Education*, *25*(6), 515–534. https://doi.org/10.1080/09500782.2011.597861

Boyd, M. P., & Smyntek-Gworek, S. (2012). Morning meeting in a third grade classroom: Literacy and learning [standards]. *The Journal of Classroom Interaction*, *47*(2), 4–12. https://www.jstor.org/stable/43858876

Bransford, J. D., Brown, A. L., & Cocking, R. R. (1999). *How people learn: Brain, mind, experience, and school*. National Academies Press.

Braun, V., & Clarke, V. (2013). *Successful qualitative research: A practical guide for beginners*. Sage.

Breuleux, A., Kobiela, M., Heo, G. M., Oliveira, I., Corriveau, C., Baradaran, N., & Beck, S. (2018a, April 13–17). *Learning in and across sites of a research-practice partnership* [Conference presentation]. Annual Meeting of the American Educational Research Association (AERA), New York, New York, United States.

Breuleux, A., Heo, G. M., Fréchette, S., Rye, K., Saada, J., & Kobiela, M. (2018b). The transformation of participation at the boundary between teaching and research practices. In M. Cukurova, J. Hunter, W. Holmes, & V. Dimitrova (Eds.), *Research-Informed Practice and Industry*. CEUR Workshop Proceedings. http://ceur-ws.org/Vol-2128/researchpractice7.pdf

Breuleux, A., Heo, G. M., Wall, T., Morgan, L., & Flores, L. (2009). Building Community through Telecollaboration (BCT) project in Quebec. *Proceedings of Society for Information Technology & Teacher Education International Conference 2009*, 819–824.

Brown, A. L., & Campione, J. C. (1996). Psychological theory and the design of innovative learning environments: On procedures, principles, and systems. In L. Schauble & R. Glaser (Eds.), *Innovations in learning: New environments for education* (pp. 289–325). Lawrence Erlbaum Associates.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, *18*(1), 32–42. https://doi.org/10.3102/0013189X018001032

Bruner, J. S. (1985). Vygotsky: A historical and conceptual perspective. In J. V. Wertsch (Ed.), *Culture, communication, and cognition: Vygotskian perspectives* (pp. 21–34). Cambridge University Press.

Bryman, A. (2003). *Quantity and quality in social research*. Routledge.

Buehl, M. M., & Beck, J. S. (2015). The relationship between teachers' beliefs and teachers' practices. In H. Fives & M. G. Gill (Eds.), *International handbook of research on teachers' beliefs* (pp. 66–84). Routledge.

Burbules, N. C. (1993). *Dialogue in teaching: Theory and practice*. Teachers College Press.

Butler, D. L., Lauscher, H. N., Jarvis-Selinger, S., & Beckingham, B. (2004). Collaboration and self-regulation in teachers' professional development. *Teaching and Teacher Education*, *20*(5), 435–455. https://doi.org/10.1016/j.tate.2004.04.003

Butler, D. L., & Winne, P. H. (1995). Feedback and self-regulated learning: A theoretical synthesis. *Review of Educational Research*, *65*(3), 245–281. https://doi.org/10.3102/00346543065003245

Cavanna, J. M. (2014). Shaping mathematics classroom discourse: Relating professional development and classroom practice [Paper presentation]. *Proceedings of the Joint Meeting of PME 38 and PME-NA 36*, *2*, 257–264.

Cazden, C., & Beck, S. W. (2003). Classroom discourse. In A. C. Graesser, M. A. Gernsbacher, & S. R. Goldman (Eds.), *Handbook of discourse processes* (pp. 165–197). Lawrence Erlbaum Associates.

Cazden, C., John-Steiner, V., & Hymes, D. H. (Eds.). (1972). *The functions of language in the classroom*. Teachers College Press.

Charmaz, K. (2006). *Constructing grounded theory*. Sage Publications.

Chee, Y. S., Mehrotra, S., & Ong, J. C. (2015). Professional development for scaling pedagogical innovation in the context of game-based learning: Teacher identity as cornerstone in "shifting" practice. *Asia-Pacific Journal of Teacher Education*, *43*(5), 423–437. https://doi.org/10.1080/1359866X.2014.962484

Chen, G., Chan, C. K. K., Chan, K. K. H., Clarke, S. N., & Resnick, L. B. (2020). Efficacy of video-based teacher professional development for increasing classroom discourse and student learning. *Journal of the Learning Sciences*, *29*(4–5), 642–680. https://doi.org/10.1080/10508406.2020.1783269

Cheng, Y., Zhang, J., Li, H., Anderson, R., Ding, F., Nguyen-Jahiel, K., Shu, H., & Wu, X. (2015). Moving from recitation to open-format literature discussion in Chinese classrooms. *Instructional Science*, *43*(6), 643–664. https://doi.org/10.1007/s11251-015-9358-5

Chinn, C. A., Anderson, R. C., & Waggoner, M. A. (2001). Patterns of discourse in two kinds of literature discussion. *Reading Research Quarterly*, *36*(4), 378–411. https://doi.org/10.1598/RRQ.36.4.3

Chiu, M. M. (2008). Flowing toward correct contributions during group problem solving: A statistical discourse analysis. *Journal of the Learning Sciences*, *17*(3), 415–463. https://doi.org/10.1080/10508400802224830

Clark, L. C. (2009). *The Next Educational Wave (NEW) teachers' collaborative: A study of inquiry-oriented professional development for beginning teachers* (Publication No. 3393914) [Doctoral dissertation, Harvard University]. ProQuest Dissertations and Theses Global.

Clarke, D., & Hollingsworth, H. (2002). Elaborating a model of teacher professional growth. *Teaching and Teacher Education*, *18*(8), 947–967. https://doi.org/10.1016/S0742-051X(02)00053-7

Clarke, D. J., & Peter, A. (1993). Modelling teacher change. In B. Atweh, C. Kanes, M. Carss, & G. Booker (Eds.), *Contexts in mathematics education. Proceedings of the 16th annual conference of the Mathematics Education Research Group of Australasia (MERGA)* (pp. 167–175). Mathematics Education Research Group of Australasia. https://pub.uni-bielefeld.de/record/2938175

Cobb, P. (1994). Where is the mind? Constructivist and sociocultural perspectives on mathematical development. *Educational Researcher*, *23*(7), 13–20. https://doi.org/10.3102/0013189X023007013

Cobb, P., Wood, T., & Yackel, E. (1990). Classrooms as learning environments for teachers and researchers. In R. B. Davis, C. A. Mayer, & N. Noddings (Eds.), *Constructivist views on*

the teaching and learning of mathematics (pp. 125–146). National Council of Teachers of Mathematics.

Cohen, E., Lotan, R., Scarloss, B., Schultz, S., & Abram, P. (2002). Can groups learn? *Teachers College Record*, *104*(6), 1045–1068.

Collins, A., Brown, J. S., & Newman, S. E. (1989). Cognitive apprenticeship: Teaching the crafts of reading, writing and mathematics. In L. B. Resnick (Ed.), *Knowing, learning, and instruction: Essays in honor of Robert Glaser* (pp. 453–494). Lawrence Erlbaum Associates.

Collins, A., & Kapur, M. (2014). Cognitive apprenticeship. In R. K. Sawyer (Ed.), *The Cambridge handbook of the learning sciences* (2nd ed., pp. 109–127). Cambridge University Press. https://doi.org/10.1017/CBO9781139519526

Colonis, M. M. (2011). *Empowering teachers to facilitate classroom mathematical discourse through participation in a professional book club* (Publication No. 3475499) [Doctoral dissertation, Purdue University]. ProQuest Dissertations and Theses Global.

Cook, S. D., & Brown, J. S. (1999). Bridging epistemologies: The generative dance between organizational knowledge and organizational knowing. *Organization Science*, *10*(4), 381–400. https://doi.org/10.1287/orsc.10.4.381

Cook, V., Warwick, P., Vrikki, M., Major, L., & Wegerif, R. (2019). Developing material-dialogic space in geography learning and teaching: Combining a dialogic pedagogy with the use of a microblogging tool. *Thinking Skills and Creativity*, *31*, 217–231. https://doi.org/10.1016/j.tsc.2018.12.005

Corbin, J. M., & Strauss, A. (1990). Grounded theory research: Procedures, canons, and evaluative criteria. *Qualitative Sociology*, *13*(1), 3–21. https://doi.org/10.1007/bf00988593

Corno, L. Y. N. (2008). On teaching adaptively. *Educational Psychologist*, *43*(3), 161–173. https://doi.org/10.1080/00461520802178466

Corriveau, C., Breuleux, A., Kobiela, M., & Oliveira, I. (2020). *Projet ARIM [Actions et rapprochements interordres en mathématiques]* [Rapport de recherche]. Fonds québécois de recherche sur la société et la culture, programme d'actions concertées sur la réussite et la persévérance scolaire. https://frq.gouv.qc.ca/app/uploads/2021/04/c.coriveau_rapport_projet-arim_prs_2016-2017.pdf

Council of Ministers of Education, Canada. (n.d.). *Global competencies*. CMEC. Retrieved August 12, 2020, from https://www.cmec.ca/682/Global_Competencies.html

Crawford, D. J. (2015). *Differentiated coaching of high school mathematics teachers: The instructional trajectory of performance tasks* (Publication No. 3720668) [Doctoral dissertation, George Mason University]. ProQuest Dissertations and Theses Global.

Creswell, J. W. (2007). *Qualitative inquiry and research design: Choosing among the five approaches* (2nd ed.). Sage.

Cronbach, L. J. (1975). Beyond the two disciplines of scientific psychology. *American Psychologist*, *30*(2), 116–127. https://doi.org/10.1037/h0076829

Cuban, L. (1984). *How teachers taught: Constancy and change in American classrooms, 1890-1980. Research on teaching monograph series.* Addison-Wesley Longman. http://eric.ed.gov/?id=ED383498

Cuban, L. (1998). High-tech schools and low-tech teaching. *Journal of Computing in Teacher Education*, *14*(2), 6–7. https://doi.org/10.1080/10402454.1998.10784333

Curtis, E., Lunn Brownlee, J., & Spooner-Lane, R. (2020). Teaching perspectives of philosophical inquiry: Changes to secondary teachers' understanding of student learning and pedagogical practices. *Thinking Skills and Creativity*, *38*, Article 100711. https://doi.org/10.1016/j.tsc.2020.100711

Damon, W., & Phelps, E. (1989). Critical distinctions among three approaches to peer education. *International Journal of Educational Research*, *13*(1), 9–19. https://doi.org/10.1016/0883-0355(89)90013-X

Damşa, C., Ludvigsen, S., & Andriessen, J. (2013). Knowledge co-construction—Epistemic consensus or relational assent? In M. Baker, J. Andriessen, & S. Järvelä (Eds.), *Affective learning together: Social and emotional dimensions of collaborative learning* (pp. 97–119). Taylor & Francis Group.

Darling-Hammond, L., Banks, J., Zumwalt, K., Gomez, L., Gamoran Sherin, M., Griesdorn, J., & Finn, L.-E. (2005). Educational goals and purposes: Developing a curricular vision for teaching. In L. Darling-Hammond & J. D. Bransford (Eds.), *Preparing teachers for a changing world: What teachers should learn and be able to do* (pp. 169–200). Jossey-Bass.

Darling-Hammond, L., & Bransford, J. D. (Eds.). (2005). *Preparing teachers for a changing world: What teachers should learn and be able to do*. Jossey-Bass.

Davies, M., Kiemer, K., & Meissel, K. (2017). Quality Talk and dialogic teaching—An examination of a professional development programme on secondary teachers'

facilitation of student talk. *British Educational Research Journal*, *43*(5), 968–987. https://doi.org/10.1002/berj.3293

Davydov, V. V. (1990). *Types of generalization in instruction: Logical and psychological problems in the structuring of school curricula. Soviet studies in mathematics education. Volume 2*. National Council of Teachers of Mathematics.

De Ruyter, D. J., & Kole, J. J. (2010). Our teachers want to be the best: On the necessity of intra-professional reflection about moral ideals of teaching. *Teachers and Teaching*, *16*(2), 207–218. https://doi.org/10.1080/13540600903478474

Deci, E. L., & Ryan, R. M. (2012). Self-determination theory. In P. A. M. Van Lange, A. W. Kruglanski, & E. T. Higgins (Eds.), *Handbook of Theories of Social Psychology: Volume 1* (pp. 416–437). Sage. https://doi.org/10.4135/9781446249215

Dembo, M. H. (2001). Learning to teach is not enough—Future teachers also need to learn how to learn. *Teacher Education Quarterly*, *28*(4), 23–35. https://www.jstor.org/stable/23478314

Denzin, N. K., & Lincoln, Y. S. (Eds.). (2000). *Handbook of qualitative research* (2nd ed.). Sage.

Denzin, N. K., & Lincoln, Y. S. (2008). *The landscape of qualitative research* (Vol. 1). Sage.

Desgagné, S. (1997). Le concept de recherche collaborative : L'idée d'un rapprochement entre chercheurs universitaires et praticiens enseignants. *Revue des sciences de l'éducation*, *23*(2), 371–393. https://doi.org/10.7202/031921ar

Desimone, L. M. (2009). Improving impact studies of teachers' professional development: Toward better conceptualizations and measures. *Educational Researcher*, *38*(3), 181–199. https://doi.org/10.3102/0013189X08331140

Dewey, J. (1933). *How we think: A restatement of the relation of reflective thinking to the educative process*. DC Heath.

Dillenbourg, P. (1999). What do you mean by collaborative learning? In P. Dillenbourg (Ed.), *Collaborative learning: Cognitive and computational approaches* (pp. 1–19). Elsevier.

Disney, A. R. (2016). *Purposefully planning for mathematics discourse: A study of teacher learning and lesson enactment* (Publication No. 10130176) [Doctoral dissertation, University of Montana]. ProQuest Dissertations and Theses Global.

Dixon, J. K., Brooks, L. A., & Carli, M. R. (2018). *Making sense of mathematics for teaching: The small group*. Solution Tree.

Donovan, M. S., & Bransford, J. D. (Eds.). (2005). *How students learn: History, mathematics, and science in the classroom*. National Academies Press.

Dudley, P. (2013). Teacher learning in Lesson Study: What interaction-level discourse analysis revealed about how teachers utilised imagination, tacit knowledge of teaching and fresh evidence of pupils learning, to develop practice knowledge and so enhance their pupils' learning. *Teaching and Teacher Education*, *34*, 107–121. https://doi.org/10.1016/j.tate.2013.04.006

Durkheim, E. (2006). *Éducation et sociologie*. Universitaires de France. (Original work published 1922)

Edmondson, E., & Choudhry, F. (2018). Talking the talk: Exploring teacher learning and their use of discourse strategies. *School Science and Mathematics*, *118*(7), 273–289. https://doi.org/10.1111/ssm.12297

Edwards, D., & Mercer, N. (1987). *Common knowledge: The development of understanding in the classroom*. Falmer.

Engeström, Y. (1999). Communication, discourse and activity. *The Communication Review*, *3*(1–2), 165–185. https://doi.org/10.1080/10714429909368577

Engeström, Y., & Sannino, A. (2010). Studies of expansive learning: Foundations, findings and future challenges. *Educational Research Review*, *5*(1), 1–24. https://doi.org/10.1016/j.edurev.2009.12.002

Engle, R. A., & Conant, F. R. (2002). Guiding principles for fostering productive disciplinary engagement: Explaining an emergent argument in a community of learners classroom. *Cognition and Instruction*, *20*(4), 399–483. https://doi.org/10.1207/S1532690XCI2004_1

Enyedy, N., Goldberg, J., & Welsh, K. M. (2006). Complex dilemmas of identity and practice. *Science Education*, *90*(1), 68–93. https://doi.org/10.1002/sce.20096

Eraut, M. (2000). Non-formal learning and tacit knowledge in professional work. *British Journal of Educational Psychology*, *70*(1), 113–136. https://doi.org/10.1348/000709900158001

Felton, M., Garcia-Mila, M., Villarroel, C., & Gilabert, S. (2015). Arguing collaboratively: Argumentative discourse types and their potential for knowledge building. *British Journal of Educational Psychology*, *85*(3), 372–386. https://doi.org/10.1111/bjep.12078

Fernández, M., Wegerif, R., Mercer, N., & Rojas-Drummond, S. (2001). Re-conceptualizing "scaffolding" and the Zone of Proximal Development in the context of symmetrical collaborative learning. *The Journal of Classroom Interaction*, *36/37*(2/1), 40–54. https://www.jstor.org/stable/23869224

Fisher, R. (2007). Dialogic teaching: Developing thinking and metacognition through philosophical discussion. *Early Child Development and Care*, *177*(6–7), 615–631. https://doi.org/10.1080/03004430701378985

Flanders, N. A. (1970). *Analyzing teaching behavior*. Addison-Wesley Publication Company.

Flitton, L., & Warwick, P. (2013). From classroom analysis to whole-school professional development: Promoting talk as a tool for learning across school departments. *Professional Development in Education*, *39*(1), 99–121. https://doi.org/10.1080/19415257.2012.719288

Ford, M., & Forman, E. A. (2015). Uncertainty and scientific progress in classroom dialogue. In L. Resnick, C. Asterhan, & S. Clarke (Eds.), *Socializing intelligence through academic talk and dialogue* (pp. 143–155). American Educational Research Association.

Freire, P. (1970a). Cultural action and conscientization. *Harvard Educational Review*, *40*(3), 452–477. https://doi.org/10.17763/haer.40.3.h76250x720j43175

Freire, P. (1970b). The adult literacy process as cultural action for freedom. *Harvard Educational Review*, *40*(2), 205–225. https://doi.org/10.17763/haer.40.2.q7n227021n148p26

Freire, P. (2000). *Pedagogy of the oppressed* (M. B. Ramos, Trans.). Continuum. (Original work published 1970)

Fullan, M. (2001). *The NEW meaning of educational change* (3rd ed.). Routledge. https://doi.org/10.4324/9780203986561

Galton, M., & Hargreaves, L. (2009). Group work: Still a neglected art? *Cambridge Journal of Education*, *39*(1), 1–6. https://doi.org/10.1080/03057640902726917

Gee, J. P., & Green, J. L. (1998). Chapter 4: Discourse analysis, learning, and social practice: A methodological study. *Review of Research in Education*, *23*(1), 119–169. https://doi.org/10.3102/0091732x023001119

Geertz, C. (1973). Thick description: Toward an interpretive theory of culture. In C. Geertz (Ed.), *The interpretation of cultures* (pp. 3–30). Basic Books.

Georgius, K. (2013). *Planning and enacting mathematical tasks of high cognitive demand in the primary classroom* (Publication No. 3618592) [Doctoral dissertation, The University of Nebraska-Lincoln]. ProQuest Dissertations and Theses Global.

Gibson, J. J. (1977). The concept of affordances. In R. Shaw & J. Bransford (Eds.), *Perceiving, acting, and knowing: Toward an ecological psychology* (pp. 56–60). Lawrence Erlbaum Associates.

Gillies, R. M. (2014). Developments in cooperative learning: Review of research. *Anales de Psicología / Annals of Psychology*, *30*(3), 792–801. https://doi.org/10.6018/analesps.30.3.201191

Gillies, R. M., & Khan, A. (2009). Promoting reasoned argumentation, problem-solving and learning during small-group work. *Cambridge Journal of Education*, *39*(1), 7–27. https://doi.org/10.1080/03057640802701945

Gilliland, E. A. (2012). *Talking about writing: Culturally and linguistically diverse adolescents' socialization into academic literacy* (Publication No. 3544732) [Doctoral dissertation, University of California, Davis]. ProQuest Dissertations and Theses Global.

Glackin, M. (2018). 'Control must be maintained': Exploring teachers' pedagogical practice outside the classroom. *British Journal of Sociology of Education*, *39*(1), 61–76. https://doi.org/10.1080/01425692.2017.1304204

Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory: Strategies for qualitative research*. Aldine de Gruyter.

Glazier, J. A. (2005). Talking and teaching through a positional lens: Recognizing what and who we privilege in our practice. *Teaching Education*, *16*(3), 231–243. https://doi.org/10.1080/10476210500204929

Goetz, T., Lüdtke, O., Nett, U. E., Keller, M. M., & Lipnevich, A. A. (2013). Characteristics of teaching and students' emotions in the classroom: Investigating differences across domains. *Contemporary Educational Psychology*, *38*(4), 383–394. https://doi.org/10.1016/j.cedpsych.2013.08.001

Göncü, A., & Gauvain, M. (2012). Sociocultural approaches to educational psychology: Theory, research, and application. In K. R. Harris, S. Graham, T. Urdan, C. B. McCormick, G. M. Sinatra, & J. Sweller (Eds.), *APA educational psychology handbook, Vol 1: Theories, constructs, and critical issues* (pp. 125–154). American Psychological Association. https://doi.org/10.1037/13273-006

Goos, M., Galbraith, P., & Renshaw, P. (2002). Socially mediated metacognition: Creating collaborative zones of proximal development in small group problem solving. *Educational Studies in Mathematics*, *49*(2), 193–223. https://doi.org/10.1023/A:1016209010120

Grossman, P., Compton, C., Igra, D., Ronfeldt, M., Shahan, E., & Williamson, P. (2009). Teaching practice: A cross-professional perspective. *Teachers College Record*, *111*(9), 2055–2100. https://doi.org/10.1177/016146810911100905

Guba, E. G., & Lincoln, Y. S. (1989). *Fourth generation evaluation*. Sage.

Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 105–117). Sage.

Guskey, T. R. (1985). Staff development and teacher change. *Educational Leadership*, *47*(7), 57–60. https://uknowledge.uky.edu/edp_facpub/21

Guskey, T. R. (1986). Staff development and the process of teacher change. *Educational Researcher*, *15*(5), 5–12. https://doi.org/10.3102/0013189X015005005

Hackling, M., Smith, P., & Murcia, K. (2011). Enhancing classroom discourse in primary science: The Puppets Project. *Teaching Science: The Journal of the Australian Science Teachers Association*, *57*(2), 18–25.

Haddy, L. J. (2008). *A conversation with Jessica: A dialogic inquiry into the developing literacy practices of a beginning teacher and a reading specialist* (Publication No. 3324331) [Doctoral dissertation, Northern Illinois University]. ProQuest Dissertations and Theses Global.

Hallberg, L. R.-M. (2006). The "core category" of grounded theory: Making constant comparisons. *International Journal of Qualitative Studies on Health and Well-Being*, *1*(3), 141–148. https://doi.org/10.1080/17482620600858399

Haneda, M., Teemant, A., & Sherman, B. (2017). Instructional coaching through dialogic interaction: Helping a teacher to become agentive in her practice. *Language and Education*, *31*(1), 46–64. https://doi.org/10.1080/09500782.2016.1230127

Hardman, F. (2020). Embedding a dialogic pedagogy in the classroom. In N. Mercer, R. Wegerif, & L. Major (Eds.), *The Routledge international handbook of research on dialogic education* (1st ed., pp. 139–151). Routledge. https://doi.org/10.4324/9780429441677

Hattie, J. A. C. (2009). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement*. Routledge.

Hattie, J., & Timperley, H. (2007). The power of feedback. *Review of Educational Research*, *77*(1), 81–112. https://doi.org/10.3102/003465430298487

Hennessy, S., Dragovic, T., & Warwick, P. (2018). A research-informed, school-based professional development workshop programme to promote dialogic teaching with

interactive technologies. *Professional Development in Education*, *44*(2), 145–168. https://doi.org/10.1080/19415257.2016.1258653

Hennessy, S., Howe, C., Mercer, N., & Vrikki, M. (2020). Coding classroom dialogue: Methodological considerations for researchers. *Learning, Culture and Social Interaction*, *25*, Article 100404. https://doi.org/10.1016/j.lcsi.2020.100404

Hennessy, S., Kershner, R., Calcagni, E., & Ahmed, F. (2021). Supporting practitioner-led inquiry into classroom dialogue with a research-informed professional learning resource: A design-based approach. *Review of Education*, *9*(3), 1–48. https://doi.org/10.1002/rev3.3269

Hennessy, S., Mercer, N., & Warwick, P. (2011). A dialogic inquiry approach to working with teachers in developing classroom dialogue. *Teachers College Record*, *113*(9), 1906–1959. https://doi.org/10.1177/016146811111300902

Hennessy, S., Rojas-Drummond, S., Higham, R., Márquez, A. M., Maine, F., Ríos, R. M., García-Carrión, R., Torreblanca, O., & Barrera, M. J. (2016). Developing a coding scheme for analysing classroom dialogue across educational contexts. *Learning, Culture and Social Interaction*, *9*, 16–44. https://doi.org/10.1016/j.lcsi.2015.12.001

Herrington, J., & Oliver, R. (2000). An instructional design framework for authentic learning environments. *Educational Technology Research and Development*, *48*(3), 23–48. https://doi.org/10.1007/BF02319856

Herrington, J., Reeves, T. C., & Oliver, R. (2009). *A guide to authentic e-learning*. Routledge.

Hetherington, L., & Wegerif, R. (2018). Developing a material-dialogic approach to pedagogy to guide science teacher education. *Journal of Education for Teaching*, *44*(1), 27–43. https://doi.org/10.1080/02607476.2018.1422611

Heyd-Metzuyanim, E., Smith, M., Bill, V., & Resnick, L. B. (2019). From ritual to explorative participation in discourse-rich instructional practices: A case study of teacher learning through professional development. *Educational Studies in Mathematics*, *101*(2), 273–289. https://doi.org/10.1007/s10649-018-9849-9

Higgins, S. (2013). Self-regulation and learning: Evidence from meta-analysis and from classrooms. In D. Whitebread, N. Mercer, C. Howe, & A. Tolmie (Eds.), *Self-regulation and dialogue in primary classrooms. British Journal of Educational Psychology Monograph Series II: Psychological Aspects of Education—Current Trends, No. 10* (pp. 111–126). British Psychological Society.

Hodkinson, H., & Hodkinson, P. (2005). Improving schoolteachers' workplace learning. *Research Papers in Education*, *20*(2), 109–131. https://doi.org/10.1080/02671520500077921

Hodkinson, P., & Hodkinson, H. (2004). The significance of individuals' dispositions in workplace learning: A case study of two teachers. *Journal of Education and Work*, *17*(2), 167–182. https://doi.org/10.1080/13639080410001677383

Hoekstra, A. (2007). *Experienced teachers' informal learning in the workplace*. Ultrecht University.

Hoekstra, A., & Korthagen, F. (2011). Teacher learning in a context of educational change: Informal learning versus systematically supported learning. *Journal of Teacher Education*, *62*(1), 76–92. https://doi.org/10.1177/0022487110382917

Hofmann, R. (2020). Dialogue, teachers and professional development. In N. Mercer, R. Wegerif, & L. Major (Eds.), *The Routledge international handbook of research on*

dialogic education (1st ed., pp. 213–216). Routledge. https://doi.org/10.4324/9780429441677

Hollingsworth, H. (1999). *Teacher professional growth: A study of primary teachers involved in mathematics professional development* [Doctoral dissertation, Deakin University]. Deakin Research Online. https://dro.deakin.edu.au/view/DU:30023471

Holt-Reynolds, D. (1991). *Practicing what we teach. Research report 91-5.* (pp. 1–27). http://eric.ed.gov/?id=ED337460

Howe, C. (2013). Dialogue and self-regulation in the primary classroom: Concluding comments. In D. Whitebread, N. Mercer, C. Howe, & A. Tolmie (Eds.), *Self-regulation and dialogue in primary classrooms. British Journal of Educational Psychology Monograph Series II: Psychological Aspects of Education—Current Trends, No. 10* (pp. 147–156). British Psychological Society.

Howe, C., & Abedin, M. (2013). Classroom dialogue: A systematic review across four decades of research. *Cambridge Journal of Education*, *43*(3), 325–356. https://doi.org/10.1080/0305764X.2013.786024

Howe, C., Hennessy, S., Mercer, N., Vrikki, M., & Wheatley, L. (2019). Teacher–student dialogue during classroom teaching: Does it really impact on student outcomes? *Journal of the Learning Sciences*, *28*(4–5), 462–512. https://doi.org/10.1080/10508406.2019.1573730

Howe, C., & Mercer, N. (2017). Commentary on the papers. *Language and Education*, *31*(1), 83–92. https://doi.org/10.1080/09500782.2016.1230126

Huberman, M. (1993). The model of the independent artisan in teachers' professional relations. In J. W. Little & M. W. McGlaughlin (Eds.), *Teachers' work: Individuals, colleagues and contexts* (pp. 11–50). Teachers College Press.

Hufferd-Ackles, K., Fuson, K. C., & Sherin, M. G. (2004). Describing levels and components of a math-talk learning community. *Journal for Research in Mathematics Education*, *35*(2), 81. https://doi.org/10.2307/30034933

Huizinga, T., Handelzalts, A., Nieveen, N., & Voogt, J. M. (2014). Teacher involvement in curriculum design: Need for support to enhance teachers' design expertise. *Journal of Curriculum Studies*, *46*(1), 33–57. https://doi.org/10.1080/00220272.2013.834077

Iiskala, T., Vauras, M., Lehtinen, E., & Salonen, P. (2011). Socially shared metacognition of dyads of pupils in collaborative mathematical problem-solving processes. *Learning and Instruction*, *21*(3), 379–393. https://doi.org/10.1016/j.learninstruc.2010.05.002

Jefferson, G. (1984). Transcription notation. In J. Atkinson & J. Heritage (Eds.), *Structures of social interaction*. Cambridge University Press.

Johnson, D. W., & Johnson, R. T. (2002). Learning together and alone: Overview and meta-analysis. *Asia Pacific Journal of Education*, *22*(1), 95–105. https://doi.org/10.1080/0218879020220110

Johnson, D. W., Maruyama, G., Johnson, R., Nelson, D., & Skon, L. (1981). Effects of cooperative, competitive, and individualistic goal structures on achievement: A meta-analysis. *Psychological Bulletin*, *89*(1), 47–62. https://doi.org/10.1037/0033-2909.89.1.47

Johnson, N., & Owen, J. (1986). *The two cultures revisited: Interpreting messages from models of teaching and clinical supervision to encourage improvement in teaching* [Paper

presentation]. The Australian Educational Research Association Annual Conference, Melbourne, Australia.

Jolicoeur, P.-L. (2020). *Apprendre à dialoguer et dialoguer pour apprendre : Pédagogie dialogique en classe collégiale*. Livres en ligne du CRIRES. https://lel.crires.ulaval.ca/oeuvre/apprendre-pour-dialoguer-et-dialoguer-pour-apprendre-pedagogie-dialogique-en-classe

Jones, D. (2007). Speaking, listening, planning and assessing: The teacher's role in developing metacognitive awareness. *Early Child Development and Care*, *177*(6–7), 569–579. https://doi.org/10.1080/03004430701378977

Juzwik, M. M., Borsheim-Black, C., Caughlan, S., & Heintz, A. (2013). *Inspiring dialogue: Talking to learn in the English classroom*. Teachers College Press.

Kaendler, C., Wiedmann, M., Rummel, N., & Spada, H. (2015). Teacher competencies for the implementation of collaborative learning in the classroom: A framework and research review. *Educational Psychology Review*, *27*(3), 505–536. https://doi.org/10.1007/s10648-014-9288-9

Kagumba, R. E. M. (2015). *Uganda science teacher educators: A concurrent mixed methods investigation of perspectives on nature of science, pedagogy, and classroom learning environment* (Publication No. 3708862) [Doctoral dissertation, Western Michigan University]. ProQuest Dissertations and Theses Global.

Kelly, A. (2009). Articulating tacit knowledge through analyses of recordings: Implications for competency assessment in the vocational education and training sector. In C. Wyatt-Smith & J. J. Cumming (Eds.), *Educational Assessment in the 21st Century* (pp. 245–262). Springer Netherlands. https://doi.org/10.1007/978-1-4020-9964-9

Kelly, R. R. (2010). *Discourse of construction: A look at how secondary reading preservice teachers conceptualize their teaching* (Publication No. 3418233) [Doctoral dissertation, Iowa State University]. ProQuest Dissertations and Theses Global.

Kiemer, K., Gröschner, A., Pehmer, A.-K., & Seidel, T. (2015). Effects of a classroom discourse intervention on teachers' practice and students' motivation to learn mathematics and science. *Learning and Instruction*, *35*, 94–103. https://doi.org/10.1016/j.learninstruc.2014.10.003

Kilinc, A., Demiral, U., & Kartal, T. (2017). Resistance to dialogic discourse in SSI teaching: The effects of an argumentation-based workshop, teaching practicum, and induction on a preservice science teacher. *Journal of Research in Science Teaching*, *54*(6), 764–789. https://doi.org/10.1002/tea.21385

Kim, M.-Y., & Wilkinson, I. A. G. (2019). What is dialogic teaching? Constructing, deconstructing, and reconstructing a pedagogy of classroom talk. *Learning, Culture and Social Interaction*, *21*, 70–86. https://doi.org/10.1016/j.lcsi.2019.02.003

King, A., & Rosenshine, B. (1993). Effects of guided cooperative questioning on children's knowledge construction. *The Journal of Experimental Education*, *61*(2), 127–148. https://doi.org/10.1080/00220973.1993.9943857

Kirschner, P. A. (2017). Stop propagating the learning styles myth. *Computers & Education*, *106*, 166–171. https://doi.org/10.1016/j.compedu.2016.12.006

Korthagen, F. (2017). Inconvenient truths about teacher learning: Towards professional development 3.0. *Teachers and Teaching*, *23*(4), 387–405. https://doi.org/10.1080/13540602.2016.1211523

Kramarski, B. (2004). Making sense of graphs: Does metacognitive instruction make a difference on students' mathematical conceptions and alternative conceptions? *Learning and Instruction*, *14*(6), 593–619. https://doi.org/10.1016/j.learninstruc.2004.09.003

Kubanyiova, M. (2015). The role of teachers' future self guides in creating l2 development opportunities in teacher-led classroom discourse: Reclaiming the relevance of language teacher cognition. *The Modern Language Journal*, *99*(3), 565–584. https://doi.org/10.1111/modl.12244

Laferrière, T., Breuleux, A., & Allaire, S. (2007). Teaching as a visible activity in remote networked schools: A socio-cultural perspective. In T. Bastiaens & S. Carliner (Eds.), *Proceedings of E-Learn 2007—World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education* (pp. 6846–6852). Association for the Advancement of Computing in Education (AACE). https://www.learntechlib.org/primary/p/26870/

Lajoie, S. P. (2008). Metacognition, self regulation, and self-regulated learning: A rose by any other name? *Educational Psychology Review*, *20*(4), 469–475. https://doi.org/10.1007/s10648-008-9088-1

Lam, C.-M. (2021). The impact of Philosophy for Children on teachers' professional development. *Teachers and Teaching*, *27*(7), 642–655. https://doi.org/10.1080/13540602.2021.1986693

Lampert, M. (2010). Learning teaching in, from, and for practice: What do we mean? *Journal of Teacher Education*, *61*(1–2), 21–34. https://doi.org/10.1177/0022487109347321

Larraín, A., Moreno, C., Grau, V., Freire, P., Salvat, I., López, P., & Silva, M. (2017). Curriculum materials support teachers in the promotion of argumentation in science

teaching: A case study. *Teaching and Teacher Education*, *67*, 522–537. https://doi.org/10.1016/j.tate.2017.07.018

Lee, L. H. J., & Tan, S. C. (2020). Teacher learning in lesson study: Affordances, disturbances, contradictions, and implications. *Teaching and Teacher Education*, *89*, Article 102986. https://doi.org/10.1016/j.tate.2019.102986

Lefstein, A., & Snell, J. (2014). *Better than best practice: Developing teaching and learning through dialogue*. Routledge.

Leinhardt, G., & Steele, M. D. (2005). Seeing the complexity of standing to the side: Instructional dialogues. *Cognition and Instruction*, *23*(1), 87–163. https://doi.org/10.1207/s1532690xci2301_4

Lemke, J. L. (1990). *Talking science*. Ablex.

Leont'ev, A. N. (1978). *Activity, consciousness, and personality*. Prentice-Hall.

Leont'ev, A. N. (1981). *Problems of the development of the mind*. Progress.

Lewis, C., Perry, R., & Murata, A. (2006). How should research contribute to instructional improvement? The case of lesson study. *Educational Researcher*, *35*(3), 3–14. https://doi.org/10.3102/0013189X035003003

Lewis, C., & Tsuchida, I. (1997). Planned educational change in Japan: The case of elementary science instruction. *Journal of Education Policy*, *12*(5), 313–331. https://doi.org/10.1080/0268093970120502

Lewis, E. B., Baker, D. R., & Helding, B. A. (2015). Science teaching reform through professional development: Teachers' use of a scientific classroom discourse community model. *Science Education*, *99*(5), 896–931. https://doi.org/10.1002/sce.21170

Lin, A. M. Y., & Lo, Y. Y. (2017). Trans/languaging and the triadic dialogue in content and language integrated learning (CLIL) classrooms. *Language and Education*, *31*(1), 26–45. https://doi.org/10.1080/09500782.2016.1230125

Lincoln, Y. S., & Lynham, S. A. (2011). Criteria for assessing theory in human resource development from an interpretive perspective. *Human Resource Development International*, *14*(1), 3–22. https://doi.org/10.1080/13678868.2011.542895

Linell, P. (1998). *Approaching dialogue: Talk, interaction and contexts in dialogical perspectives*. John Benjamins Publishing Company.

Lipman, M. (2003). *Thinking in education* (2nd ed.). Cambridge University Press. https://doi.org/10.1017/CBO9780511840272

Lloyd, G. M. (2008). Teaching mathematics with a new curriculum: Changes to classroom organization and interactions. *Mathematical Thinking and Learning*, *10*(2), 163–195. https://doi.org/10.1080/10986060701854482

Luoto, J. (2020). Scrutinizing two Finnish teachers' instructional rationales and perceived tensions in enacting student participation in mathematical discourse. *LUMAT: International Journal on Math, Science and Technology Education*, *8*(1), 133–161. https://doi.org/10.31129/LUMAT.8.1.1329

Magnusson, S., Krajcik, J., & Borko, H. (1999). Nature, sources, and development of pedagogical content knowledge for science teaching. In J. Gess-Newsome & N. Lederman (Eds.), *Examining pedagogical content knowledge: The construct and its implications for science education* (pp. 95–132). Kluwer Academic Publishers.

Males, L. M., Otten, S., & Herbel-Eisenmann, B. A. (2010). Challenges of critical colleagueship: Examining and reflecting on mathematics teacher study group interactions. *Journal of*

Mathematics Teacher Education, *13*(6), 459–471. https://doi.org/10.1007/s10857-010-9156-6

Mansvelder-Longayroux, D. D., Beijaard, D., & Verloop, N. (2007). The portfolio as a tool for stimulating reflection by student teachers. *Teaching and Teacher Education*, *23*(1), 47–62. https://doi.org/10.1016/j.tate.2006.04.033

Matsumura, L. C., Correnti, R., Walsh, M., Bickel, D. D., & Zook-Howell, D. (2019). Online content-focused coaching to improve classroom discussion quality. *Technology, Pedagogy and Education*, *28*(2), 191–215. https://doi.org/10.1080/1475939X.2019.1577748

Matusov, E. (2009). *Journey into dialogic pedagogy*. Nova Science.

Maybin, J., Mercer, N., & Stierer, B. (1992). "Scaffolding" learning in the classroom. In K. Norman (Ed.), *Thinking voices: The work of the National Oracy Project* (pp. 186–195). Hodder & Stoughton.

McAneny, K. M. (2013). *Teachers' voices: Experiencing work outside of professional development* (Publication No. 3598709) [Doctoral dissertation, University of Delaware]. ProQuest Dissertations and Theses Global.

McConney, M. (2013). *Communicating according to the Standards: Examining math talk in Chinese and U.S. mathematics classrooms* (Publication No. 3603498) [Doctoral dissertation, University of Illinois at Urbana-Champaign]. ProQuest Dissertations and Theses Global.

McKeown, M. G., & Beck, I. L. (2004). Transforming knowledge into professional development resources: Six teachers implement a model of teaching for understanding text. *The Elementary School Journal*, *104*(5), 391–408. https://doi.org/10.1086/499759

McMillan, J. H. (2016). *Fundamentals of educational research* (7th ed.). Pearson.

Mehan, H. (1979). *Learning lessons: Social organization in the classroom*. Harvard University Press.

Mehan, H., & Wood, H. (1975). The morality of ethnomethodology. *Theory and Society*, *2*(4), 509–530. https://www.jstor.org/stable/657068

Melville, W. (2008). Mandated curriculum change and a science department: A superficial language convergence? *Teaching and Teacher Education*, *24*(5), 1185–1199. https://doi.org/10.1016/j.tate.2007.03.004

Mercer, N. (1994). Neo-Vygotskian theory and classroom education. In B. Stierer & J. Maybin (Eds.), *Language, literacy, and learning in educational practice: A reader* (pp. 92–110). Multilingual Matters.

Mercer, N. (1995). *The guided construction of knowledge: Talk amongst teachers and learners*. Multilingual Matters.

Mercer, N. (2004). Sociocultural discourse analysis: Analysing classroom talk as a social mode of thinking. *Journal of Applied Linguistics*, *1*(2), 137–168. https://doi.org/10.1558/japl.2004.1.2.137

Mercer, N. (2008). The seeds of time: Why classroom dialogue needs a temporal analysis. *Journal of the Learning Sciences*, *17*(1), 33–59. https://doi.org/10.1080/10508400701793182

Mercer, N. (2013). The social brain, language, and goal-directed collective thinking: A social conception of cognition and its implications for understanding how we think, teach, and learn. *Educational Psychologist*, *48*(3), 148–168. https://doi.org/10.1080/00461520.2013.804394

Mercer, N., & Dawes, L. (2014). The study of talk between teachers and students, from the 1970s until the 2010s. *Oxford Review of Education*, *40*(4), 430–445. https://doi.org/10.1080/03054985.2014.934087

Mercer, N., & Littleton, K. (2007). *Dialogue and the development of children's thinking: A sociocultural approach*. Routledge.

Mercer, N., Wegerif, R., & Major, L. (Eds.). (2020). *The Routledge international handbook of research on dialogic education* (1st ed.). Routledge. https://doi.org/10.4324/9780429441677

Mevarech, Z. R., & Kramarski, B. (1997). IMPROVE: A multidimensional method for teaching mathematics in heterogeneous classrooms. *American Educational Research Journal*, *34*(2), 365–394. https://doi.org/10.3102/00028312034002365

Mevarech, Z. R., Verschaffel, L., & De Corte, E. (2018). Metacognitive pedagogies in mathematics classrooms: From kindergarten to college and beyond. In D. H. Schunk & J. A. Greene (Eds.), *Handbook of self-regulation of learning and performance, 2nd ed* (pp. 109–123). Routledge/Taylor & Francis Group.

Meyer, A. (2016). *Let's talk about text: A case study of early elementary teachers refining their practice to facilitate whole group text-based discussion while supporting ELL students* (Publication No. 10128886) [Doctoral dissertation, Michigan State University]. ProQuest Dissertations and Theses Global.

Michaels, S., O'Connor, C., & Resnick, L. B. (2008). Deliberative discourse idealized and realized: Accountable talk in the classroom and in civic life. *Studies in Philosophy and Education*, *27*(4), 283–297. https://doi.org/10.1007/s11217-007-9071-1

Mik-Meyer, N. (2020). Multimethod qualitative research. In D. Silverman (Ed.), *Qualitative Research* (pp. 357–374). Sage.

Miller, R. (2014). Introducing Vygotsky's cultural-historical psychology. In A. Yasnitsky, R. van der Veer, & M. Ferrari (Eds.), *The Cambridge handbook of cultural-historical psychology* (pp. 9–46). Cambridge University Press.

Ministère de l'Éducation du Québec. (2008a). *Québec education program: Elementary education*. Gouvernement du Québec. http://www.education.gouv.qc.ca/fileadmin/site_web/documents/dpse/formation_jeunes/ecr_elementary.pdf

Ministère de l'Éducation du Québec. (2008b). *Québec education program: Secondary education*. Gouvernement du Québec. http://www.education.gouv.qc.ca/fileadmin/site_web/documents/dpse/formation_jeunes/ecr_secondary.pdf

Ministère de l'Éducation du Québec. (2017). *Policy on educational success*. Gouvernement du Québec. http://www.education.gouv.qc.ca/fileadmin/site_web/documents/PSG/politiques_orientations/politique_reussite_educative_10juillet_A_1.pdf

Ministère de l'Éducation du Québec. (2019). *Référentiel d'intervention en mathématique*. Gouvernement du Québec. http://www.education.gouv.qc.ca/fileadmin/site_web/documents/dpse/adaptation_serv_compl/Referentiel-mathematique.pdf

Ministère de l'Éducation du Québec. (2020). *Référentiel de compétences professionnelles de la profession enseignante*. Gouvernement du Québec. https://cdn-contenu.quebec.ca/cdn-

contenu/adm/min/education/publications-adm/devenir-enseignant/referentiel_competences_professionnelles_profession_enseignante.pdf?1606848024

Ministère de l'Education et de l'Enseignement supérieur. (2022, February 3). *Gouvernance scolaire*. https://www.quebec.ca/education/prescolaire-primaire-et-secondaire/gouvernance-scolaire/

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, *108*(6), 1017–1054.

Morrissette, J. (2013). Recherche-action et recherche collaborative : Quel rapport aux savoirs et à la production de savoirs? *Nouvelles pratiques sociales*, *25*(2), 35–49. https://doi.org/10.7202/1020820ar

Morse, J. M. (2000). Determining sample size. *Qualitative Health Research*, *10*(1), 3–5.

Morse, J. M. (2015). Critical analysis of strategies for determining rigor in qualitative inquiry. *Qualitative Health Research*, *25*(9), 1212–1222. https://doi.org/10.1177/1049732315588501

Morse, J. M., Bowers, B. J., Charmaz, K., Clarke, A. E., Corbin, J., Porr, C. J., & Stern, P. N. (Eds.). (2021). *Developing grounded theory: The second generation revisited* (2nd ed.). Routledge. https://doi.org/10.4324/9781315169170

Mortimer, E., & Scott, P. (2003). *Meaning making in secondary science classrooms*. McGraw-Hill Education.

Muhonen, H., Rasku-Puttonen, H., Pakarinen, E., Poikkeus, A.-M., & Lerkkanen, M.-K. (2016). Scaffolding through dialogic teaching in early school classrooms. *Teaching and Teacher Education*, *55*, 143–154. https://doi.org/10.1016/j.tate.2016.01.007

Munby, H. (1984). A qualitative approach to the study of a teacher's beliefs. *Journal of Research in Science Teaching*, *21*(1), 27–38. https://doi.org/10.1002/tea.3660210104

Murphy, C., Abu-Tineh, A., Calder, N., & Mansour, N. (2018). Implementing dialogic inquiry in Qatari mathematics and science classrooms: Challenges and provocations. *Teachers and Curriculum*, *18*(1). https://doi.org/10.15663/tandc.v18i1.318

National Research Council. (2013). *Education for life and work: Guide for practitioners* [Online booklet]. https://www.nap.edu/resource/13398/dbasse_084153.pdf

Nelson, T. H. (2009). Teachers' collaborative inquiry and professional growth: Should we be optimistic? *Science Education*, *93*(3), 548–580. https://doi.org/10.1002/sce.20302

Nelson, T. O., & Narens, L. (1994). Why investigate metacognition? In J. Metcalfe & A. P. Shimamura (Eds.), *Metacognition: Knowing about knowing* (pp. 1–26). MIT Press.

Nespor, J. (1987). The role of beliefs in the practice of teaching. *Journal of Curriculum Studies*, *19*(4), 317–328. https://doi.org/10.1080/0022027870190403

Newberry, M., & Richardson, M. (2015). Exploring metaphoric language use to assess collaboration between educational institutions. *School Leadership & Management*, *35*(4), 422–440. https://doi.org/10.1080/13632434.2015.1070820

Newman, C. S. (2000). Seeds of professional development in pre-service teachers: A study of their dreams and goals. *International Journal of Educational Research*, *33*(2), 125–217. https://doi.org/10.1016/S0883-0355(00)00003-3

Newman, R. (2017). Let's talk talk: Utilising metatalk for the development of productive collaborative dialogues. *Thinking Skills and Creativity*, *26*, 1–12. https://doi.org/10.1016/j.tsc.2017.04.006

Nussbaum, E. M., & Bendixen, L. D. (2003). Approaching and avoiding arguments: The role of epistemological beliefs, need for cognition, and extraverted personality traits. *Contemporary Educational Psychology*, *28*(4), 573–595. https://doi.org/10.1016/S0361-476X(02)00062-0

Nystrand, M., Gamoran, A., Kachur, R., & Prendergast, C. (1997). *Opening dialogue: Understanding the dynamics of language and learning in the English classroom*. Teachers College Press.

Nystrand, M., Wu, L. L., Gamoran, A., Zeiser, S., & Long, D. A. (2003). Questions in time: Investigating the structure and dynamics of unfolding classroom discourse. *Discourse Processes*, *35*(2), 135–198. https://doi.org/10.1207/S15326950DP3502_3

O'Connor, M. C., & Michaels, S. (1993). Aligning academic task and participation status through revoicing: Analysis of a classroom discourse strategy. *Anthropology & Education Quarterly*, *24*(4), 318–335. https://doi.org/10.1525/aeq.1993.24.4.04x0063k

O'Donnell, A. M. (2012). Constructivism. In K. R. Harris, S. Graham, T. Urdan, C. B. McCormick, G. M. Sinatra, & J. Sweller (Eds.), *APA educational psychology handbook, Vol 1: Theories, constructs, and critical issues* (pp. 61–84). American Psychological Association. https://doi.org/10.1037/13273-003

OECD. (2017). *The OECD handbook for innovative learning environments*. OECD. https://read.oecd-ilibrary.org/education/the-oecd-handbook-for-innovative-learning-environments_9789264277274-en

Oliveira, A. W. (2010). Developing elementary teachers' understanding of the discourse structure of inquiry-based science classrooms. *International Journal of Science and Mathematics Education*, *8*(2), 247–269. https://doi.org/10.1007/s10763-009-9172-0

Omland, M., & Rødnes, K. A. (2020). Building agency through technology-aided dialogic teaching. *Learning, Culture and Social Interaction*, *26*, Article 100406. https://doi.org/10.1016/j.lcsi.2020.100406

Osborne, J. F., Borko, H., Fishman, E., Gomez Zaccarelli, F., Berson, E., Busch, K. C., Reigh, E., & Tseng, A. (2019). Impacts of a practice-based professional development program on elementary teachers' facilitation of and student engagement with scientific argumentation. *American Educational Research Journal*, *56*(4), 1067–1112. https://doi.org/10.3102/0002831218812059

Packer, M. J., & Goicoechea, J. (2000). Sociocultural and constructivist theories of learning: Ontology, not just epistemology. *Educational Psychologist*, *35*(4), 227–241. https://doi.org/10.1207/S15326985EP3504_02

Palmer, P. J. (1998). *The courage to teach*. Jossey-Bass.

Papert, S. A. (1980). *Mindstorms: Children, computers, and powerful ideas*. Basic Books.

Pehmer, A.-K., Gröschner, A., & Seidel, T. (2015). Fostering and scaffolding student engagement in productive classroom discourse: Teachers' practice changes and reflections in light of teacher professional development. *Learning, Culture and Social Interaction*, *7*, 12–27. https://doi.org/10.1016/j.lcsi.2015.05.001

Pekrun, R. (2006). The control-value theory of achievement emotions: Assumptions, corollaries, and implications for educational research and practice. *Educational Psychology Review*, *18*(4), 315–341. https://doi.org/10.1007/s10648-006-9029-9

Perry, N. E. (2013). Understanding classroom processes that support children's self-regulation of learning. In D. Whitebread, N. Mercer, C. Howe, & A. Tolmie (Eds.), *Self-regulation and dialogue in primary classrooms. British Journal of Educational Psychology Monograph*

Series II: Psychological Aspects of Education—Current Trends, No. 10 (pp. 45–67). British Psychological Society.

Perry, N. E., Lisaingo, S., Yee, N., Parent, N., Wan, X., & Muis, K. (2020). Collaborating with teachers to design and implement assessments for self-regulated learning in the context of authentic classroom writing tasks. *Assessment in Education: Principles, Policy & Practice*, *27*(4), 416–443. https://doi.org/10.1080/0969594X.2020.1801576

Perry, T., Davies, P., & Brady, J. (2020). Using video clubs to develop teachers' thinking and practice in oral feedback and dialogic teaching. *Cambridge Journal of Education*, *50*(5), 615–637. https://doi.org/10.1080/0305764X.2020.1752619

Phillipson, N., & Wegerif, R. (2019). The Thinking Together approach to dialogic teaching. In E. Manalo (Ed.), *Deeper Learning, dialogic learning, and critical thinking: Research-based strategies for the classroom* (pp. 32–47). Routledge.

Piaget, J. (1965). *The moral judgment of the child* (M. Gabain, Trans.). Free Press. (Original work published 1932)

Piaget, J. (1970). *Genetic epistemology*. Columbia University Press.

Polojac-Chenoweth, D. L. (2020). *Textbooks as a tool for planning and facilitating mathematical discourse* (Publication No. 28024810) [Doctoral dissertation, University of South Florida]. ProQuest Dissertations and Theses Global.

Postholm, M. B. (2012). Teachers' professional development: A theoretical review. *Educational Research*, *54*(4), 405–429. https://doi.org/10.1080/00131881.2012.734725

Postholm, M. B. (2015). Methodologies in cultural–historical activity theory: The example of school-based development. *Educational Research*, *57*(1), 43–58. https://doi.org/10.1080/00131881.2014.983723

Rathgen, E. (2006). In the voice of teachers: The promise and challenge of participating in classroom-based research for teachers' professional learning. *Teaching and Teacher Education*, *22*(5), 580–591. https://doi.org/10.1016/j.tate.2006.01.004

Resnick, L., Asterhan, C., & Clarke, S. (Eds.). (2015). *Socializing intelligence through academic talk and dialogue*. American Educational Research Association.

Reznitskaya, A., & Gregory, M. (2013). Student thought and classroom language: Examining the mechanisms of change in dialogic teaching. *Educational Psychologist*, *48*(2), 114–133. https://doi.org/10.1080/00461520.2013.775898

Richardson, V. (1996). The role of attitudes and beliefs in learning to teach. In J. Sikula (Ed.), *Handbook of research on teacher education* (2nd ed., pp. 102–119). Macmillan.

Rodgers, C. (2002). Defining reflection: Another look at John Dewey and reflective thinking. *Teachers College Record*, *104*(4), 842–866.

Rojas-Drummond, S., Torreblanca, O., Pedraza, H., Vélez, M., & Guzmán, K. (2013). 'Dialogic scaffolding': Enhancing learning and understanding in collaborative contexts. *Learning, Culture and Social Interaction*, *2*(1), 11–21. https://doi.org/10.1016/j.lcsi.2012.12.003

Roschelle, J., & Teasley, S. D. (1995). The construction of shared knowledge in collaborative problem solving. In C. O'Malley (Ed.), *Computer Supported Collaborative Learning* (pp. 69–97). Springer. https://doi.org/10.1007/978-3-642-85098-1_5

Rumenapp, J. C. (2016). Analyzing discourse analysis: Teachers' views of classroom discourse and student identity. *Linguistics and Education*, *35*, 26–36. https://doi.org/10.1016/j.linged.2016.04.002

Sale, J. E. M., Lohfeld, L. H., & Brazil, K. (2002). Revisiting the quantitative-qualitative debate: Implications for mixed-methods research. *Quality and Quantity*, *36*(1), 43–53. https://doi.org/10.1023/A:1014301607592

Säljö, R. (2009). Learning, theories of learning, and units of analysis in research. *Educational Psychologist*, *44*(3), 202–208. https://doi.org/10.1080/00461520903029030

Santagata, R. (2011). From teacher noticing to a framework for analyzing and improving classroom lessons. In M. G. Sherin, V. R. Jacobs, & R. A. Philipp (Eds.), *Mathematics teacher noticing: Seeing through teachers' eyes* (pp. 152–168). Routledge.

Scherrer, J., & Stein, M. K. (2013). Effects of a coding intervention on what teachers learn to notice during whole-group discussion. *Journal of Mathematics Teacher Education*, *16*(2), 105–124. https://doi.org/10.1007/s10857-012-9207-2

Schön, D. A. (1983). *The reflective practitioner: How professionals think in action*. Basic Books.

Schön, D. A. (1987). *Educating the reflective practitioner: Toward a new design for teaching and learning in the professions.* Jossey-Bass.

Scott, P. H., Mortimer, E. F., & Aguiar, O. G. (2006). The tension between authoritative and dialogic discourse: A fundamental characteristic of meaning making interactions in high school science lessons. *Science Education*, *90*(4), 605–631. https://doi.org/10.1002/sce.20131

Sedova, K. (2017a). Transforming teacher behaviour to increase student participation in classroom discourse. *Teacher Development*, *21*(2), 225–242. https://doi.org/10.1080/13664530.2016.1224775

Sedova, K. (2017b). A case study of a transition to dialogic teaching as a process of gradual change. *Teaching and Teacher Education*, *67*, 278–290. https://doi.org/10.1016/j.tate.2017.06.018

Sedova, K., Sedlacek, M., & Svaricek, R. (2016). Teacher professional development as a means of transforming student classroom talk. *Teaching and Teacher Education*, *57*, 14–25. https://doi.org/10.1016/j.tate.2016.03.005

Sengupta-Irving, T., & Agarwal, P. (2017). Conceptualizing perseverance in problem solving as collective enterprise. *Mathematical Thinking and Learning*, *19*(2), 115–138. https://doi.org/10.1080/10986065.2017.1295417

Seymour, J. R., & Lehrer, R. (2006). Tracing the Evolution of Pedagogical Content Knowledge as the Development of Interanimated Discourses. *Journal of the Learning Sciences*, *15*(4), 549–582. https://doi.org/10.1207/s15327809jls1504_5

Sezen, A. (2011). *From the teachers' eyes: An ethnographic-case study on developing models of Informal Formative Assessments (IFA) and understanding the challenges to effective implementation in science classrooms* [Doctoral dissertation, Pennsylvania State University]. PennState Graduate School eTD Database. https://etda.libraries.psu.edu/catalog/11848

Sfard, A. (1998). On two metaphors for learning and the dangers of choosing just one. *Educational Researcher*, *27*(2), 4–13. https://doi.org/10.3102/0013189X027002004

Sfard, A. (2015). Why all this talk about talking classrooms? Theorizing the relation between talking and learning. In L. Resnick, C. Asterhan, & S. Clarke (Eds.), *Socializing intelligence through academic talk and dialogue* (pp. 245–253). American Educational Research Association.

Sfard, A. (2020). Learning, discursive faultiness and dialogic engagement. In N. Mercer, R. Wegerif, & L. Major (Eds.), *The Routledge international handbook of research on dialogic education* (1st ed., pp. 89–99). Routledge. https://doi.org/10.4324/9780429441677

Shilo, A., & Kramarski, B. (2019). Mathematical-metacognitive discourse: How can it be developed among teachers and their students? Empirical evidence from a videotaped lesson and two case studies. *ZDM*, *51*(4), 625–640. https://doi.org/10.1007/s11858-018-01016-6

Shor, I., & Freire, P. (1987). What is the "dialogical method" of teaching? *Journal of Education*, *169*(3), 11–31. https://doi.org/10.1177/002205748716900303

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, *15*(2), 4–14. https://doi.org/10.3102/0013189X015002004

Shulman, L. S., & Shulman, J. H. (2009). How and what teachers learn: A shifting perspective. *Journal of Education*, *189*(1–2), 1–8. https://doi.org/10.1177/0022057409189001-202

Sinclair, J., & Coulthard, M. (1975). *Towards an analysis of discourse: The English used by teachers and pupils*. Oxford University Press.

Slavin, R. E. (1980). Cooperative learning. *Review of Educational Research*, *50*(2), 315–342. https://doi.org/10.3102/00346543050002315

Slavin, R. E. (1996). Research on cooperative learning and achievement: What we know, what we need to know. *Contemporary Educational Psychology*, *21*(1), 43–69. https://doi.org/10.1006/ceps.1996.0004

Slavin, R. E., Lake, C., & Groff, C. (2009). Effective programs in middle and high school mathematics: A best-evidence synthesis. *Review of Educational Research*, *79*(2), 839–911. https://doi.org/10.3102/0034654308330968

Smith, F., Hardman, F., Wall, K., & Mroz, M. (2004). Interactive whole class teaching in the National Literacy and Numercy Strategies. *British Educational Research Journal*, *30*(3), 395–411. https://doi.org/10.1080/0141192041000168970 6

Snell, J., & Lefstein, A. (2018). "Low ability," participation, and identity in dialogic pedagogy. *American Educational Research Journal*, *55*(1), 40–78. https://doi.org/10.3102/0002831217730010

Stahl, G. (2006). Supporting group cognition in an online math community: A cognitive tool for small-group referencing in text chat. *Journal of Educational Computing Research*, *35*(2), 103–122. https://doi.org/10.2190/Q435-7611-2561-720P

Stipek, D. J., Givvin, K. B., Salmon, J. M., & MacGyvers, V. L. (2001). Teachers' beliefs and practices related to mathematics instruction. *Teaching and Teacher Education*, *17*(2), 213–226. https://doi.org/10.1016/S0742-051X(00)00052-4

Strauss, A., & Corbin, J. (1990). *Basics of qualitative research: Grounded theory procedures and techniques*. Sage.

Strauss, A. L. (1987). *Qualitative analysis for social scientists*. Cambridge University Press.

Tabak, I., & Kyza, E. A. (2018). Research on scaffolding in the learning sciences. In F. Fischer, C. E. Hmelo-Silver, S. R. Goldman, & P. Reimann (Eds.), *International Handbook of the Learning Sciences* (1st ed., pp. 191–200). Routledge. https://doi.org/10.4324/9781315617572-19

Taylor, J., & Cox, B. D. (1997). Microgenetic analysis of group-based solution of complex two-step mathematical world problems by fourth graders. *Journal of the Learning Sciences*, *6*(2), 183–226. https://doi.org/10.1207/s15327809jls0602_2

Teräs, H., & Kartoğlu, Ü. (2017). A grounded theory of professional learning in an authentic online professional development program. *The International Review of Research in Open and Distributed Learning*, *18*(7), 191–212. https://doi.org/10.19173/irrodl.v18i7.2923

Thomson, S. B. (2010). Sample size and grounded theory. *Journal of Administration and Governance*, *5*(1), 45–52. https://ssrn.com/abstract=3037218

Traga Philippakos, Z. A., Munsell, S., & Robinson, L. (2019). Combining strategy instruction and principles of dialogic pedagogy to support primary-grade students story writing: Results from cycle 1 of design research. *Literacy Research and Instruction*, *58*(4), 253–271. https://doi.org/10.1080/19388071.2019.1644405

Troiano, B. (2012). *Developing professional teacher researchers: Transforming language learning through discourse analysis* (Publication No. 3552500) [Doctoral dissertation, University of Illinois at Chicago]. ProQuest Dissertations and Theses Global.

T-SEDA Collective. (2019). *Teacher scheme for educational dialogue analysis (T-SEDA) v.7b resource pack*. University of Cambridge. http://bit.ly/T-SEDA

T-SEDA Collective. (2021). *Teacher scheme for educational dialogue analysis (T-SEDA) v.8a resource pack*. University of Cambridge. http://bit.ly/T-SEDA

van de Pol, J., Brindley, S., & Higham, R. J. E. (2017). Two secondary teachers' understanding and classroom practice of dialogic teaching: A case study. *Educational Studies*, *43*(5), 497–515. https://doi.org/10.1080/03055698.2017.1293508

Van der Maren, J.-M. (1996). *Méthodes de recherche pour l'éducation*. Presses de l'Université de Montréal et de Boeck.

van der Veen, C., & van Oers, B. (2017). Advances in research on classroom dialogue: Learning outcomes and assessments. *Learning and Instruction*, *48*, 1–4. https://doi.org/10.1016/j.learninstruc.2017.04.002

van Es, E. A., & Sherin, M. G. (2010). The influence of video clubs on teachers' thinking and practice. *Journal of Mathematics Teacher Education*, *13*(2), 155–176. https://doi.org/10.1007/s10857-009-9130-3

Vedder-Weiss, D., Lefstein, A., Segal, A., & Pollak, I. (2020). Dilemmas of leadership and capacity building in a research–practice partnership. *Teachers College Record: The Voice of Scholarship in Education*, *122*(9), 1–30. https://doi.org/10.1177/016146812012200914

Veenman, M. V. J., & Spaans, M. A. (2005). Relation between intellectual and metacognitive skills: Age and task differences. *Learning and Individual Differences*, *15*(2), 159–176. https://doi.org/10.1016/j.lindif.2004.12.001

Vermunt, J. D., & Endedijk, M. D. (2011). Patterns in teacher learning in different phases of the professional career. *Learning and Individual Differences*, *21*(3), 294–302. https://doi.org/10.1016/j.lindif.2010.11.019

Volet, S., Summers, M., & Thurman, J. (2009). High-level co-regulation in collaborative learning: How does it emerge and how is it sustained? *Learning and Instruction*, *19*(2), 128–143. https://doi.org/10.1016/j.learninstruc.2008.03.001

Voloshinov, V. N. (1973). *Marxism and the philosophy of language* (L. Matejka & I. R. Titunik, Trans.). Seminar Press. (Original work published 1929)

Voogt, J. M., Pieters, J. M., & Handelzalts, A. (2016). Teacher collaboration in curriculum design teams: Effects, mechanisms, and conditions. *Educational Research and Evaluation*, *22*(3–4), 121–140. https://doi.org/10.1080/13803611.2016.1247725

Voogt, J., Westbroek, H., Handelzalts, A., Walraven, A., McKenney, S., Pieters, J., & de Vries, B. (2011). Teacher learning in collaborative curriculum design. *Teaching and Teacher Education*, *27*(8), 1235–1244. https://doi.org/10.1016/j.tate.2011.07.003

Vrikki, M., Kershner, R., Calcagni, E., Hennessy, S., Lee, L., Hernández, F., Estrada, N., & Ahmed, F. (2019). The teacher scheme for educational dialogue analysis (T-SEDA): Developing a research-based observation tool for supporting teacher inquiry into pupils' participation in classroom dialogue. *International Journal of Research & Method in Education*, *42*(2), 185–203. https://doi.org/10.1080/1743727X.2018.1467890

Vrikki, M., Warwick, P., & Rødnes, K. A. (2021). Developing a frame for action with digital technology through extending teacher noticing. *Teacher Development*, *25*(4), 393–410. https://doi.org/10.1080/13664530.2021.1939769

Vygotsky, L. S. (1962). *Thought and language* (E. Hanfmann & G. Vakar, Trans.). MIT Press. (Original work published 1934)

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes* (M. Cole, V. John-Steiner, S. Scribner, & E. Souberman, Eds.; A. Luria, M. Lopez-Morillas, M. Cole, & J. Wertsch, Trans.). Harvard University Press.

Vygotsky, L. S. (1981). The genesis of higher mental functions. In J. V. Wertsch (Ed. & Trans.), *The concept of activity in Soviet psychology* (pp. 144–188). M. E. Sharpe. (Original work published 1931)

Vygotsky, L. S. (1987). Thinking and speech. In R. W. Rieber & A. S. Carton (Eds.), & N. Minick (Trans.), *The collected works of L. S. Vygotsky: Volume 1 Problems of General Psychology* (pp. 39–285). Plenum Press. (Original work published 1934)

Wall, A. E. T., Breuleux, A., Heo, G. M., Rye, K., Goyetche, M.-H., & Lemay, V. (2011). Teacher-based inquiry in the BCT project. *LEARNing Landscapes*, *4*(2), 325–344. https://doi.org/10.36510/learnland.v4i2.403

Wallen, M., & Tormey, R. (2019). Developing teacher agency through dialogue. *Teaching and Teacher Education*, *82*, 129–139. https://doi.org/10.1016/j.tate.2019.03.014

Walsh, S. (2002). Construction or obstruction: Teacher talk and learner involvement in the EFL classroom. *Language Teaching Research*, *6*(1), 3–23. https://doi.org/10.1191/1362168802lr095oa

Wang, M. C., Haertel, G. D., & Walberg, H. J. (1990). What influences learning? A content analysis of review literature. *The Journal of Educational Research*, *84*(1), 30–43. https://doi.org/10.1080/00220671.1990.10885988

Warwick, P., Vrikki, M., Vermunt, J. D., Mercer, N., & van Halem, N. (2016). Connecting observations of student and teacher learning: An examination of dialogic processes in Lesson Study discussions in mathematics. *ZDM*, *48*(4), 555–569. https://doi.org/10.1007/s11858-015-0750-z

Waymouth, H. E. (2020). *Educators' understanding of scientific sensemaking and literacy: A cultural-historical activity theory analysis* (Publication No. 27834088) [Doctoral dissertation, Syracuse University]. ProQuest Dissertations and Theses Global.

Webb, N. M. (1989). Peer interaction and learning in small groups. *International Journal of Educational Research*, *13*(1), 21–39. https://doi.org/10.1016/0883-0355(89)90014-1

Webb, N. M., & Mastergeorge, A. M. (2003). The development of students' helping behavior and learning in peer-directed small groups. *Cognition and Instruction*, *21*(4), 361–428. https://doi.org/10.1207/s1532690xci2104_2

Wegerif, R. (2008). Dialogic or dialectic? The significance of ontological assumptions in research on educational dialogue. *British Educational Research Journal*, *34*(3), 347–361. https://doi.org/10.1080/01411920701532228

Wegerif, R. (2011). Towards a dialogic theory of how children learn to think. *Thinking Skills and Creativity*, *6*(3), 179–190. https://doi.org/10.1016/j.tsc.2011.08.002

Wegerif, R. (2013). *Dialogic: Education for the Internet age*. Routledge.

Wegerif, R. (2020). Introduction to the theory of dialogic education. In N. Mercer, R. Wegerif, & L. Major (Eds.), *The Routledge international handbook of research on dialogic education* (1st ed., pp. 11–13). Routledge. https://doi.org/10.4324/9780429441677

Wegerif, R., & Dawes, L. (2004). *Thinking and learning with ICT: Raising achievement in primary classrooms*. Routledge.

Wegerif, R., & Mercer, N. (1997). Using computer-based text analysis to integrate qualitative and quantitative methods in research on collaborative learning. *Language and Education*, *11*(4), 271–286. https://doi.org/10.1080/09500789708666733

Wegerif, R., Mercer, N., & Dawes, L. (1999). From social interaction to individual reasoning: An empirical investigation of a possible socio-cultural model of cognitive development. *Learning and Instruction*, *9*(6), 493–516. https://doi.org/10.1016/S0959-4752(99)00013-4

Wells, G. (1993). Reevaluating the IRF sequence: A proposal for the articulation of theories of activity and discourse for the analysis of teaching and learning in the classroom. *Linguistics and Education*, *5*(1), 1–37. https://doi.org/10.1016/S0898-5898(05)80001-4

Wells, G. (1999). *Dialogic inquiry: Toward a sociocultural practice and theory of education*. Cambridge University Press.

Wells, G. (2007). Semiotic mediation, dialogue and the construction of knowledge. *Human Development*, *50*(5), 244–274. https://doi.org/10.1159/000106414

Wenger, E. (1998). *Communities of practice: Learning, meaning and identity*. Cambridge University Press.

Wertsch, J. V. (1980). The significance of dialogue in Vygotsky's account of social, egocentric, and inner speech. *Contemporary Educational Psychology*, *5*(2), 150–162. https://doi.org/10.1016/0361-476X(80)90036-3

Wertsch, J. V. (Ed.). (1985). *Culture, communication, and cognition: Vygotskian perspectives*. Cambridge University Press.

Westgate, D., & Hughes, M. (2016). Speaking and listening in the primary curriculum: Some themes and their impact. *Education 3-13*, *44*(4), 478–495. https://doi.org/10.1080/03004279.2014.1002515

Whitebread, D., Mercer, N., Howe, C., & Tolmie, A. (Eds.). (2013a). Classroom talk and the development of self-regulation and metacognition. In *Self-regulation and dialogue in primary classrooms. British Journal of Educational Psychology Monograph Series II: Psychological Aspects of Education—Current Trends, No. 10* (pp. 1–23). British Psychological Society.

Whitebread, D., Mercer, N., Howe, C., & Tolmie, A. (Eds.). (2013b). *Self-regulation and dialogue in primary classrooms. British Journal of Educational Psychology Monograph Series II: Psychological Aspects of Education—Current Trends, No. 10*. British Psychological Society.

Whitebread, D., & Pino-Pasternak, D. (2010). Metacognition, self-regulation and meta-knowing. In K. Littleton, C. Wood, & J. Kleine Staarman (Eds.), *International Handbook of Psychology in Education* (pp. 673–711). Emerald.

Widjaja, W., Vale, C., Groves, S., & Doig, B. (2017). Teachers' professional growth through engagement with lesson study. *Journal of Mathematics Teacher Education*, *20*(4), 357–383. https://doi.org/10.1007/s10857-015-9341-8

Wilkinson, I. A. G., Murphy, P. K., & Binici, S. (2015). Dialogue-intensive pedagogies for promoting reading comprehension: What we know, what we need to know. In L. Resnick, C. Asterhan, & S. Clarke (Eds.), *Socializing intelligence through academic talk and dialogue* (pp. 37–50). American Educational Research Association.

Wilkinson, I. A. G., Reznitskaya, A., Bourdage, K., Oyler, J., Glina, M., Drewry, R., Kim, M.-Y., & Nelson, K. (2017). Toward a more dialogic pedagogy: Changing teachers' beliefs and practices through professional development in language arts classrooms. *Language and Education*, *31*(1), 65–82. https://doi.org/10.1080/09500782.2016.1230129

Williams, J., & Ryan, J. (2020). On the compatibility of dialogism and dialectics: The case of mathematics education and professional development. *Mind, Culture, and Activity*, *27*(1), 70–85. https://doi.org/10.1080/10749039.2019.1686026

Winne, P. H. (2018). Cognition and metacognition within self-regulated learning. In D. H. Schunk & J. A. Greene (Eds.), *Handbook of self-regulation of learning and performance* (2nd ed., pp. 36–48). Routledge.

Winne, P. H., & Hadwin, A. (1998). Studying as self-regulated engagement in learning. In D. Hacker, J. Dunlosky, & A. Graesser (Eds.), *Metacognition in educational theory and practice* (pp. 277–304). Lawrence Erlbaum.

Wood, D., Bruner, J. S., & Ross, G. (1976). The role of tutoring in problem solving. *Journal of Child Psychology and Psychiatry*, *17*(2), 89–100. https://doi.org/10.1111/j.1469-7610.1976.tb00381.x

Yackel, E., Cobb, P., & Wood, T. (1991). Small-group interactions as a source of learning opportunities in second-grade mathematics. *Journal for Research in Mathematics Education*, *22*(5), 390–408. https://doi.org/10.2307/749187

Zhang, M., Lundeberg, M., & Eberhardt, J. (2010). Seeing what you normally don't see. *Phi Delta Kappan*, *91*(6), 60–65. https://doi.org/10.1177/003172171009100615

Zheng, X., Zhang, J., & Wang, W. (2019). Teacher learning as boundary crossing: A case study of Master Teacher Studios in China. *Teachers and Teaching*, *25*(7), 837–854. https://doi.org/10.1080/13540602.2019.1673358

Zinchenko, V. P., & Davydov, V. V. (1985). Foreword. In J. V. Wertsch (Ed.), *Vygotsky and the social formation of mind* (pp. vii–xi). Harvard University Press.

Appendices

Appendix A

Table A 1

Database Search Strategy and Output

Database	Search strategy	# of research papers
PsycINFO	("teacher learning" or "professional development" or "teacher development").mp and ("dialogic$ teaching" or "dialogic$ pedagogy" or "dialogic$ education" or "dialogic$ inquiry" or "dialogic$ method" or "dialogically organized instruction" or "collaborative reasoning" or "thinking together" or "inquiry dialogue" or "accountable talk" or "productive dialogue" or "classroom discourse" or "discursive cultures").mp	114
ERIC	("teacher learning" or "professional development" or "teacher development") and ("dialogic* teaching" or "dialogic* pedagogy" or "dialogic* education" or "dialogic* inquiry" or "dialogic* method" or "dialogically organized instruction" or "collaborative reasoning" or "thinking together" or "inquiry dialogue" or "accountable talk" or "productive dialogue" or "classroom discourse" or "discursive cultures")	160
	Sub-total (before removal of duplicates)	274
	Total (after duplicates were removed)	221

Table A 2

Selection Process for Systematic Scoping Review

Identification	Database search results after duplicates removed (*n* = 221)	
Screening - Round 1	Titles/Abstracts (*n* = 221)	
	Keep if	Reject if
	Articles meet basic selection criteria (basic education/K-12 + teacher learning/PD + dialogic/discourse-focused/dialogue-intensive pedagogies)	Article did not address the basic selection criteria or was not relevant to the purpose of review. For example, articles were excluded if addressed preschool teachers, drama education, undergraduate instruction Article treats student learning but not teacher learning (e.g., students' vocabulary development, multiplication strategies) Article treats researcher learning but not teacher learning Surveyed university students, no apparent link to teachers Focus on PLCs without any link to classrooms or classroom dialogue 3 articles were more or less repeats (I retained the most recent and arguably more coherent article) Focus on researchers' observations of the classroom (importance of dual rigor + responsiveness) but do not treat teacher learning
	→ Retained (*n* = 141)	→ Rejected (*n* = 80)
Screening - Round 2	Rapid read-through of full text (*n* = 141)	
	Keep if	Reject if
	Idem	*Idem*
	→ Retained (*n* = 94)	→ Rejected (*n* = 47)
Eligibility check	In-depth full-text screening (*n* = 94)	
	Keep if	Reject if
	Empirically investigates one or multiple facets of teacher learning and/or has the potential to explain the	Teacher learning is mentioned conceptually or peripherally but not investigated (e.g., implications of

	"why" of teacher adoption (or non-adoption) of dialogic/discourse-focused/dialogue-intensive pedagogies using empirical evidence	classroom discourse for future research on teacher learning) Microteaching (training) sessions, rather than authentic in-class, are investigated When more than one article was based on the same data set, the more recent or more comprehensive article was retained. Focus on teachers' fidelity to PD without investigating teacher learning processes or mechanisms Focus on numeracy coordinators (not teachers) PD does not focus on social or discursive interactions in the classroom (e.g., teachers focus on individual student interviews) The article is inaccessible Commentary, theoretical essays, and general reports were excluded
	→ Retained (n = 63)	→ Rejected (n = 31)
Included	Included in literature review (n = 63)	

Table A 3

Geographic Locations Represented in the Literature Review

Country/Region	1982-1991	1992-2001	2002-2011	2012-2021	Total	%
USA	1	0	10	24	35	56%
UK	0	0	1	7	8	13%
Czech Republic	0	0	0	3	3	5%
China	0	0	0	2	2	3%
Turkey	0	0	0	2	2	3%
Australia	0	0	2	1	3	5%
Chile	0	0	0	1	1	2%
Finland	0	0	0	1	1	2%
Hong Kong	0	0	0	1	1	2%
Ireland	0	0	0	1	1	2%
New Zealand	0	0	0	1	1	2%
Qatar	0	0	0	1	1	2%
Singapore	0	0	0	1	1	2%
Slovakia	0	0	0	1	1	2%
Uganda	0	0	0	1	1	2%
International (multiple countries)	0	0	0	1	1	2%
Total	1	0	13	49	63	
%	2%	0%	21%	78%		

Table A 4

Curricular Contexts Represented in the Literature Review

Subject	1982-1991	1992-2001	2002-2011	2012-2021	Total	%
Literacy	0	0	3	8	11	17%
Math	0	0	3	12	15	24%
Science	0	0	5	12	17	27%
Social studies	0	0	0	1	1	2%
Cross-curricular	0	0	0	3	3	5%
Combined subjects	1	0	2	7	10	16%
Second language instruction	0	0	0	6	6	10%
Total	1	0	13	49	63	
%	2%	0%	21%	78%		

Table A 5

Grade Levels Represented in the Literature Review

Early primary (5-7 years old; app. K-Grade 2) [EP]	Late primary (7-11 yrs old; app. Grades 3-5) [LP]	Primary (Age? Or in between EP and LP) [PS]	Early secondary (11-14 years old; app. Grades 6-8) [ES]	Late secondary (14-17 years old; app. Grades 9-12) [LS]	Secondary (Age? Or in between ES and LS) [SS]	Spanned both primary and secondary levels [BL]	Not specified [NS]	Total	Primary (%)	Secondary (%)	Both Primary and Secondary (%)
5	7	6	12	8	10	14	1	63	29%	48%	22%

Appendix B

Workshop Materials Overview

Theme	Topics	Learning objectives	Examples of teacher discussion and learning activities	Select references (non-exhaustive)
Promoting a dialogic classroom climate	Dialogue and dialogic teaching	Collectively explore dialogic teaching concepts and strategies for promoting a dialogic classroom climate	Open interaction analysis	Bakhtin, 1981; Vygotsky, 1934/1987; Wertsch, 1980 T-SEDA Collective, 2019; Barnes, 1976; Howe et al., 2019; Mercer, 1995; Mercer & Littleton, 2007; Michaels, O'Connor, & Resnick, 2008; Nystrand et al., 2003; Phillipson & Wegerif, 2020; Vrikki et al., 2019; Wegerif & Mercer, 1997
	Dialogic group norms	Be able to identify verbal signs of productive dialogue	Discussion on productive talk moves, guided interaction analysis Student checklists (T-SEDA)	
Scaffolding quality dialogue	Dialogue and metacognition	Collectively reflect on the application of dialogic principles, tasks or strategies in	Open discussion on teachers' classroom implementation/ experimentation	Iiskala et al., 2011; Mevarech et al., 2018; Perry et al., 2020; Volet et al., 2009; Winne, 2018;

		teachers' classrooms		Winne & Hadwin, 1998
	Introduction to principles of self-regulated learning	Understand basic task principles for promoting self-regulation	Teacher self-assessment on dialogic teaching (T-SEDA) Promoting dialogic norms (online activity)	
Planning and facilitating high-quality tasks for dialogic and metacognitive goals	Review task principles for self-regulation	Be able to identify strategies in own practice that promote (or hinder) productive dialogue	Open discussions on teachers' lived experiences enacting/experimenting with dialogue-intensive tasks	Dixon et al., 2018; Howe, 2013; Kramarski, 2004; Meverech & Kramarski, 1997; Sengupta-Irving & Agarwal, 2017; Slavin et al., 2009 Shilo & Kramarski, 2019; Taylor & Cox, 1997; Webb & Mastergeorge, 2003
	From small-group to whole-class follow-up	Analyze the implications of dialogue and metacognition for teaching practice more broadly	Scaffolding small group tasks for self-regulation: Do's and Don'ts Discussion on ways to help students develop reflexive habits	

Appendix C

Pre-Workshop Interview Questions (Semi-Structured)

Theme	Questions/Prompts
Introductions/ Demographics	What led you to participate in this study? What grade do you teach? How long have you been teaching?
Classroom dialogue	What comes to mind when you hear the word "dialogue"? What might "productive dialogue" look like in your classroom? Reminder: There are no right or wrong answers. How often do you experience or observe productive dialogue in your classroom? Are you familiar with "dialogic teaching"? Would you like to describe/guess what "dialogic teaching" might be/mean?
Small-group activities	How often do you organize small-group activities in your classroom? How often would you say your colleagues organize small-group activities? Would you say that small-group activities are "easier" to organize with particular groups of students? Would you say that small-group activities are "easier" to organize in specific subject matters (English vs. math)? At particular levels of education (primary vs. secondary)? How do you decide which students work together? Do you have any strategies for forming groups? How many students to put in the same group? Are there any particular learning targets or curricular goals that, for you, easily align with small group activities? Would you say that there are certain learning targets or curricular goals that are impossible to achieve with small-group activities? What types of tasks do you do in small-group activities (e.g., open, closed, combination)? What would a "good" math task for small-group activities look like for you? Do you have any/Can you describe the routines that you use to introduce small-group activities? Do you have any/Can you describe the routines you have during small-group activities? Any signals you look for while students are working in groups? How do you assess whether a small-group activity is successful? Reminder: There are no right or wrong answers. Do you have any/Can you describe your follow-up routines? What influenced you the most to use small-group activities in the way that you do today?
Whole-class discussions	How would you describe the strategies that you use to help students understand mathematical concepts or procedures during whole class discussions? What influenced you the most to use these whole-class discussion strategies in the way that you do today?

Preparedness/ Self-efficacy	On a scale of 1 to 5, how would you rate your level of preparedness to organize or plan small-group activities in your math class, where 1 means “limited” and 5 means “very well prepared”. On a scale of 1 to 5, how confident do you feel in your ability to facilitate productive small-group activities in your classroom, where 1 means “Not confident at all” and 5 means “Very confident.” On a scale of 1 to 5, how confident do you feel in your ability to facilitate productive whole-class dialogue in your classroom, where 1 means “Not confident at all.” and 5 means “Very confident.” On a scale of 1 to 5, how would you rate your level of comfort inviting students to build on or respond to their peers’ ideas during whole-class discussions, where 1 means “limited” and 5 means “very well prepared”. On a scale of 1 to 5, how would you rate your students’ level of comfort building on or responding to their peers’ ideas during whole-class discussions, where 1 means “limited” and 5 means “very well prepared”.
Overall take-aways	At the end of the day, what do you hope that students take away from your math class?

Appendix D

Post-Workshop Interview Questions (Semi-Structured)

Theme	Questions/Prompts
Participation in the workshops	First of all, how did you find the whole experience of participating in this study? In the workshops? (challenges / opportunities) During the workshops you had the opportunity to hear the experiences of other teachers (to interact with other teachers). How did you find this part of the workshops? Now, if you think back to the content of the workshops, were there any specific topics that you found particularly useful for your own classroom practice? Were there certain topics that were a bit difficult to understand, abstract, too conceptual? Did you learn something new?
Changing perspectives: Classroom dialogue	Now, going back to this idea of dialogue. During the first interview, I asked what comes to your mind when you hear the word "dialogue". What comes to your mind when you hear the word "dialogue" now? Reminder: There are no right or wrong answers. What might "productive" dialogue look like in your classroom? How often would you say you experience productive dialogue in your classroom nowadays? What does dialogic teaching mean to you? What makes teaching "dialogic"? Would you say that your teaching has changed since the first interview? What do you think has influenced this change? What were some of the ideas or examples of dialogue that we saw during the workshops that stood out to you the most? Would you say the workshops (or other aspects of the study) changed your perspective on classroom dialogue? What about small group activities? (If so, how? In designing or choosing the activity, what to do during / after the activity)? On metacognition, self-regulation? Was there perhaps a specific question / challenge that you would have liked to discuss in more depth? Did you have chance to implement any of the ideas that we discussed during the workshops? About dialogue, metacognition or self-regulation?
Preparedness / Self-efficacy	On a scale of 1 to 5, how would you rate your level of preparedness to organize or plan small-group activities in your math class, where 1 means "limited" and 5 means "very well prepared". On a scale of 1 to 5, how confident do you feel in your ability to facilitate productive small-group activities in your classroom, where 1 means "Not confident at all" and 5 means "Very confident." On a scale of 1 to 5, how confident do you feel in your ability to facilitate productive whole-class dialogue in your classroom, where 1 means "Not confident at all." and 5 means "Very confident."

	On a scale of 1 to 5, how would you rate your level of comfort inviting students to build on or respond to their peers' ideas during whole-class discussions, where 1 means "limited" and 5 means "very well prepared". On a scale of 1 to 5, how would you rate your students' level of comfort building on or responding to their peers' ideas during whole-class discussions, where 1 means "limited" and 5 means "very well prepared".
Future workshops	Would you be interested in other workshops like these? (Not necessarily led by me. But more in terms of the format, the online workshops, is that something that interests you? If so, what would you like to see? (E.g. more meetings, more collaborative activities, etc.)?

Appendix E

Overview of Data Sources and Collection Methods

Data Source	*Method*	Role (# of participants)	Total Duration (*Mean, St. Dev.*)
Teachers' pre-workshop responses	*Semi-structured interviews*	Teachers (*n* = 12), Researcher	11 hr 49 min (*M* = 59 min, *SD* = 13 min)
Online workshop discourse	*Workshop intervention/Focus group style questions*	Teachers (*n* = 11), Educational Consultants (*n* = 2), Researcher	15 hr 42 min (*M* = 1 hr 44 min, *SD* = 11 min)
Whole classroom discourse	*Ethnographic observations*	Teachers (*n* = 7), Students (*n* = 113), Pedagogical Consultants (*n* = 2)	6 hr 20 min (*M* = 12 min, *SD* = 12 min)
Student-led small-group discourse	*Ethnographic observations*	Students (*n* = 25), Teachers (*n* = 7)	5 hr 19 min (*M* = 22 min, *SD* = 11 min)
Teachers' classroom observations	*Questionnaire*	Teachers (*n* = 10)	na
Teachers' post-workshop responses	*Semi-structured interviews*	Teachers (*n* = 10), Researcher	7 hr 33 min (*M* = 45 min, *SD* = 9 min)
Observational notes and memos	*Reflexive memo writing*	Researcher	na

Appendix F

Simplified Jeffersonian Notation

Symbol	Name	Use
[text] or /text/	Brackets or forward slashes	Indicates the start and end points of overlapping speech.
(# of seconds)	Noteworthy pause	A number in parentheses indicates the time, in seconds, of a pause in speech.
(.)	Micropause	Indicates a brief but clearly marked interruption, usually less than 0.2 seconds. The following utterance is semantically continuous. E.g., *It might be (.) nice.*
.	Period	Primarily used for semantic clarity to indicate the end of a complete idea, usually indicated by falling pitch.
[…]	Ellipsis in brackets	Indicates omitted speech.
?	Question mark	Primarily used for semantic clarity to indicate a question asked, usually indicated by rising pitch
,	Comma	Indicates a temporary rise or fall in intonation.
-- or —	Double hyphen or m dash	Indicates an abrupt halt or interruption in the middle of a word or utterance such that the following utterance is grammatically or semantically different than that of the interrupted utterance. E.g., *I've taught absolutely every-- yeah, I think the only grades (1.5) the only grades I haven't taught is Grade 2.*
‘text’	Single quotation marks	Indicates reported speech, such as when a speaker is quoting somebody else. E.g., *He said, 'No, it can't be!’*
<u>text</u>	Underlined text	Indicates the speaker is emphasizing or stressing the speech.
(text)	Parentheses	Indicates unclear speech in the transcript with best guess written in parentheses. Also used when describing laughter, e.g., (laughs), or inaudible speech, e.g., (inaudible)
((*text*))	Double parentheses, text in italics	Annotation of non-verbal activity, such as gestures or contextual information important to the comprehension of the utterance.

Appendix G

Phase 1—Broad Categories Emerging During Open Coding

Emerging categories	# of teachers	Code frequency
Dialogue	10	44
Productive dialogue	10	55
Successful small groups	10	29
PCK (math + small group tasks)	6	39
Intuitive use of knowledge on metacognition	10	59
PK (strategies for organizing small-group tasks)	10	99
Past experiences influence on current practice	9	42
Teaching and learning beliefs	10	95
Overarching teaching goals and motives	9	43
Teachers' observations of classroom interactions	9	41
Teacher dispositions	10	87
Motivation to participate in research	6	14
Teachers receive support	10	49
Constraints hindering classroom dialogue (e.g., pedagogical planning affected by COVID)	7	33

Note. PCK=pedagogical content knowledge, PK=pedagogical knowledge

Appendix H

Phase 1—Teachers' Conceptualizations of Successful Small Groups

CATEGORY/**Sub-category**/Code	**# of teachers**	**Code frequency**
SUCCESSFUL SMALL GROUPS		29
Progress in the activity	**5**	**11**
Students complete the task		2
Ability to explain back what they have done		1
Everyone talks a little, but toward precise goal		1
*Quality over quantity		3
*Small group math tasks as having easily quantifiable goals		1
*Complex task criterion=completion; games=engagement		1
Written task performance/Autonomy	**5**	**10**
Left work in a way that someone else can understand		1
Autonomy in the task		2
Checklist for students		4
Successful transfer to individual tasks		2
* Uses written evaluation, but convinced written isn't only way		1
Non-verbal signs	**4**	**8**
Everyone wants to participate		2
Class ambiance + results		1
Engagement: class loses track of time		2
Something seen in their faces, physical, emotional		2
Something in their eyes		1

Note. Negative case analyses (*) reveal instances that contradict or qualify the sub-category/code.

Appendix I

Teachers' Intuitive Use of Knowledge on Metacognition in Discussion-Based Math Tasks

CATEGORY/**Sub-category**/Code	**# of teachers**	**Code frequency**
INTUITIVE USE OF KNOWLEDGE ON METACOGNITION	**10**	59
Emotion regulation	**4**	**5**
Associates student motivation with clear goals		1
Linking negative emotion to inefficient strategy		2
Links stress to goal expectations, fear of having wrong answer		1
Implicitly links discouragement w/ not finishing a task		1
(Re)activate prior knowledge	**6**	**8**
Establishes problem/Planning/Goal setting	**8**	**15**
Activate task understanding/goal setting		2
Planning/Goal setting		1
Making students' answers an object of reflection		1
Making students' questions an object of reflection		2
Understand first before resolving the problem		4
With weaker students: Drawing for understanding		1
Questions weaker students to help them name the problem		1
Clarifies task for students		1
Group tasks should solicit a real problem, links to concept		1
Instruction-centred goal setting		1
Addressing different strategies	**6**	**10**
Group as resource for thinking		1
Teacher makes her learning visible		1
Using songs for memory retention		2
Encourages pattern-seeking		2
Linking strategies to problems, avoiding compartmentalization		1
Links abstract term to strategy		1
Demonstrates strategies, asks students to explain		1
Reflection on activity and multiple ways of getting to answer		1
Monitoring/Checking progress	**6**	**12**
Asks students where they went wrong		1
Teacher monitors understanding and reflects for students		5
Teacher gives students hints, directs attention to goal		2
Implicit monitoring		2
Students explicitly monitor their understanding (e.g., checklist)		2
Reflection for future action	**2**	**2**

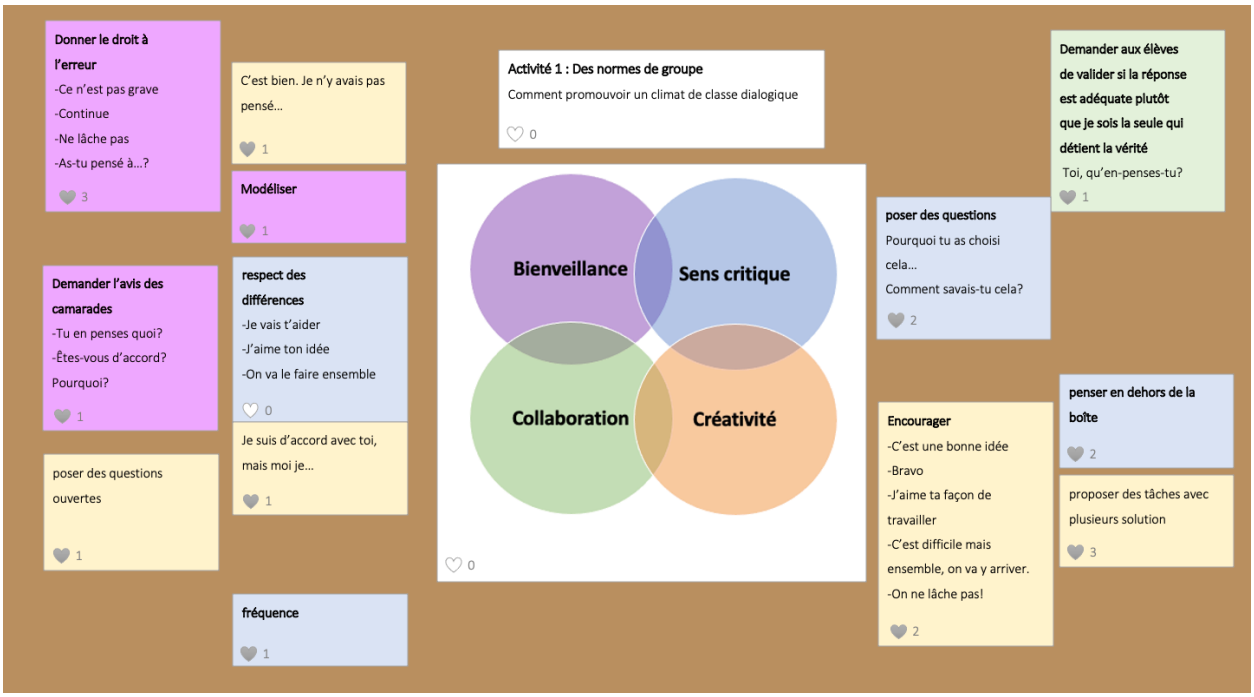
Reflection on learning for future application		1
Priming students for future learning goals		1
Autonomy	**4**	**7**
Students create activity for someone else		1
Tests delayed memory (although by default because caught by the bell)		1
Individual transfer activity after feedback		1
Clarity is important for students to be able to self-manage		1
Students find their own solution		1
Students understand better when they can figure it out themselves		1
Success when students can progress alone, autonomy		1

Appendix J

Example of Online Workshop Activity for Teachers

Activity 1: Group Norms / Activité 1 : Des normes de groupe

Establishing a Dialogic Classroom Climate / Comment promouvoir un climat de classe dialogique



Note. Example from Workshop 2, Group 2 Primaire. Different colored post-its represent different teachers. Each teacher chose their post-it color at the beginning of the activity. The educational consultant posted one green post-it. The post-its were placed in proximity of the "bubble" to which it was associated. For information, this representation is a reproduction of the teachers' activity responses given in an online platform (padlet.com/). This activity was inspired by Phillipson and Wegerif's (2019) "ground rules" activity, which is also available online (http://21stcenturylearners.org.uk/?p=1166).