

**Attending to Relationship: A Narrative Inquiry into Teachers'
Experiences with Community and Place
in Mathematics Education**

by

Amanda Fritzlan

B.Sc., McGill University, 1990

B.Ed., The University of British Columbia, 2006

M.Ed., The University of British Columbia, 2013

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The following individuals certify that they have read, and recommend to the Faculty of Graduate and Postdoctoral Studies for acceptance, the dissertation entitled:

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submitted by Amanda Fritzlán in partial fulfillment of the requirements for

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in Curriculum Studies

Examining Committee:

Cynthia Nicol, Professor, Department of Curriculum & Pedagogy, UBC

Supervisor

Susan Gerofsky, Associate Professor, Department of Curriculum & Pedagogy, UBC

Supervisory Committee Member

Ann Anderson, Professor, Department of Curriculum & Pedagogy, UBC

University Examiner

Marla Buchanan, Professor, Department of Educational & Counselling Psychology & Special Education, UBC

University Examiner

Additional Supervisory Committee Members:

Michael Marker, Associate Professor, Department of Educational Studies, UBC

Supervisory Committee Member

Abstract

The purpose of this study is to explore the ways in which relationships that teachers build with community and place shape mathematics education. It takes place in the context of urban and culturally diverse elementary public-school classrooms. This study occurs at a time when teachers across Canada are engaging in conversations and exploring strategies to bring Indigenous perspectives into all school subject areas, including mathematics. This is a response to calls for appropriate action to address the devastating legacy of residential schools for Indigenous students.

Narrative inquiry research methodology was used to inquire into the storied experiences of seven non-Indigenous teachers from a school district in the Lower Mainland of British Columbia. Data gathered in a series of meetings that spanned the school year included: audio recordings, my own field notes, photographs of shared teaching resources, and email correspondence. Data analysis included three phases: (1) co-composition with each teacher of an ‘Individual Narrative’ account of our meetings; (2) the identification of ‘Resonant Narrative Threads’ across all seven of the ‘Individual Narratives’; and (3) a re-reading of the teachers’ narratives within the context of broader institutional and popular dominant narratives with attention to teachers’ counter narratives.

Findings illuminate how elementary school mathematics teachers negotiate the tension between institutional and popular notions of an abstract universalizing curriculum at three sites of questioning: (1) Who can do math? (2) What counts as math? and (3) How can we relate with place through math? Details of all of the teachers’ descriptions of their day-to-day practices share common themes of deeply considering what success in mathematics means, whose math they are modelling for their students, and the agency of place in their lessons.

This study contributes to the field of culturally responsive mathematics education by specifically focusing on an urban and culturally diverse context and adds to discussions of socio-cultural values in mathematics education. Through privileging teachers' voices this study contributes to recent research that foregrounds issues of agency and identity in mathematics education. Teachers' shared narratives demonstrate specific strategies and issues for non-Indigenous teachers engaging with Indigenous perspectives in mathematics education.

Lay Summary

This is a study of the ways that teachers' relationship with community and place affect how they teach mathematics. It focuses on the experiences of non-Indigenous elementary school teachers in the Lower Mainland of British Columbia, Canada. The connection of mathematics with cultural knowledge and practices is central to this project.

Findings indicate that elementary school mathematics teachers reach out to their students' parents and communities in different ways. They work to build meaningful relationships that affect how they teach mathematics and are concerned for their students' general well-being. To connect with place, teachers describe their mathematics lessons occurring outdoors.

The teachers in this study look to Indigenous educators and professional resources to bring Indigenous perspectives into their mathematics lessons. They are respectful of Indigenous knowledge holders that visit their schools and are concerned about appropriate protocols for working with Indigenous perspectives in their classrooms.

Preface

This dissertation required the approval of the University of British Columbia's Behavioural Research Ethics Board. The study was covered by UBC Ethics Certificate # H18-03450. This dissertation is original, unpublished, independent work by the author, Amanda Fritzlan.

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Dedication

This dissertation is dedicated first and foremost to my partner, Marcus. Your loving support and writerly wisdom has carried me through. I could not have done this without you.

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CHAPTER 1: INTRODUCTION

1.1 Identifying the Research Puzzle

This study begins with an assumption that mathematics and mathematics education is a socio-cultural endeavour. Culturally specific practices of counting, measuring, locating, designing, playing, and explaining may be considered mathematical (Bishop, 1988). And, the ways that mathematics is taught in schools is based on cultural practices (Averill et al., 2009; Furuto, 2014; Nicol, Archibald & Baker, 2013; Sterenberg, 2013; Wagner & Lunney Borden, 2015). The application of mathematical thinking in our lives reflects social and cultural values (Bishop, 1988, 2012; Frankenstein, 1983, 2015; O’Neil, 2016) and political issues of identity, agency, and power (Gutiérrez, 2013, 2018; Gutstein, 2006; Peterson, 2015; Walls, 2006).

In unquestioned systems of universalized mathematics teaching, learning, and assessment, dominant cultural values and political agendas prevail (Aikenhead, 2017; Little Bear, 2000). The separation of mathematics teaching and learning practice from politics, ethics and cultural values (Gutiérrez, 2018) is dehumanizing. As well, a hegemonic agenda of disciplinarity (strict division of academic disciplines) further serves capitalist and colonizing influences in education (Smith in Smith, Tuck & Yang, 2018), including mathematics.

Conversely, a culturally and politically responsive approach to teaching mathematics strives to ensure that each student has an opportunity to be successful.

Teachers in British Columbia, Canada, practice mathematics education with unique and diverse communities of students and families¹, and in unique and diverse places. Each community is characterized by their social values, cultural practices, and personal or community histories. Each place contains meaning held in its stories and histories and has the potential to

¹ I intend the use of the terms “families” as well as “parents” to include guardians and other significant caregivers in the lives of elementary school students throughout this dissertation.

play a role in the education of students (Archibald, 2008; Basso, 1996; Marker, 2018). This doctoral research project is an inquiry into the ways in which elementary school teachers of mathematics respond to the places where they work and the communities with whom they work. It is concerned with how relationships with community and place shape their teaching practices.

The research puzzle (Clandinin, 2013) that this study addresses is complicated by the need for teachers to negotiate relationships with particular communities and places while working within the context of universalizing institutional practices such as common curriculum directives and standardized assessment. For example, in British Columbia, all elementary school teachers follow the same provincial curriculum documents for mathematics (Province of British Columbia, 2021). Teachers may feel pressure to follow specific grade level content and skills outlined in provincial curriculum documents or in resource materials provided by their school district at a prescribed pace.

Elementary school mathematics teachers may also feel concerned about having their students perform well on standardized assessment practices. In my own recent experience as an elementary school teacher, it was required that I administer annual numeracy assessments of my students. My understanding of the purpose of these assessments was that they were to inform administrators of educational successes and of areas of need. One of these assessments is the provincial Foundational Skills Assessment (FSA) for all Grade 4 and 7 students. Students' scores on the FSA are not reflected in their school report cards. However, the results of this particular assessment are published online as an interactive map (Fraser Institute, 2019) that ranks schools by their students' scores on these numeracy tests. This public ranking may affect the culture of a particular school and the relationships between teachers and parents.

In schools, a sense of belonging is often discussed outside of the realm of curriculum. However, responding to place and community in education means that curriculum must be a part of the community and connected to the land where it claims to live. Further, students for whom the social values of their homes and communities are not in alignment with the dominant school social values may not feel that they belong or are recognized for their cultural identities or personal histories (Pinar, 2016). Curricular projects that do not recognize the cultural practices and perspectives of their students and their families may be considered to be tools of cultural assimilation. Residential schools for Indigenous children practiced cultural assimilation of Indigenous students in Canada from the 1870s until 1996. They were a central part of federal policy that has been described as “cultural genocide” (Truth and Reconciliation Commission of Canada, 2015a, p. 1).

All elementary school teachers in Canada are responsible to the *Truth and Reconciliation Commission (TRC) of Canada: Calls to Action*, to “redress the legacy of residential schools” (Truth and Reconciliation Commission of Canada, 2015b). The legacy of residential schools for Indigenous students, as well as their families and communities, consists of cultural and personal damages educationally instituted for over 150 years and that still exist today. The 94 *TRC Calls to Action* include seven that directly call for changes to Canadian government policy and practice in education. These include addressing Indigenous education through “developing culturally appropriate curricula” (Sec. 10, iii, p. 2), and “identifying teacher–training needs” to build “student capacity for intercultural understanding” (Sec. 63, iv & iii, p. 7).

Canadian curriculum theorists (Butler, Ng-a-Fook, Vaudrin-Charette & McFadden, 2015; Chamber, 2008) write about the need for non-Indigenous education scholars and practitioners to critically examine their own personal histories and practices and to recognize the limits of

dominant Western epistemological perspectives. They also write of the immediate responsibility in the context of addressing the *Truth and Reconciliation Commission (TRC) of Canada: Calls to Action* for “teacher educators, teachers, and teacher candidates to become political actors, engaged citizens, within each of their particular spheres of influence” (Ng-A-Fook in Butler et al., p. 57).

I embark on this research project by way of a narrative inquiry (Clandinin, 2006, 2013; Clandinin & Rosik, 2007; Connelly & Clandinin, 1988, 2006) with seven teacher participants who are all employed as teachers in elementary school grades by the same district in the Lower Mainland of British Columbia. I enter into conversations with each of these teachers for the purpose of studying their experiences. My primary research question is:

In what ways do teachers’ experiences of relationships with community and place shape their strategies for teaching mathematics in an urban and culturally diverse context?

I do not expect this research project to yield definitive answers to the research puzzle with which it engages. My hope is to open and extend these complicated conversations of negotiating relationship with community and place in mathematics education in a way that may contribute to related fields of research and that also may be shared with elementary school mathematics educators.

1.2 Getting to Know the Research Landscape

The second chapter of this dissertation is a review of literature that relates to my research puzzle. I begin with the topic of mathematical knowledge and mathematics education considered as culturally grounded human endeavours that reflect social values and worldviews. The following portion of my literature review concerns research into mathematics education and social justice. Mathematics education in relationship with place is my third area of focus. Issues,

tensions, and gaps or openings in mathematics education research that emerge through this review of the research landscape not only become guides for my research action, but also compound the impetus to carry out this study. I briefly outline below three of these sites of interest for this study that are a part of my Chapter Two extended literature review.

One gap that I identify in research into Indigenous perspectives and mathematics education relates directly to my study. The field of culturally responsive mathematics education (CRME) research has primarily explored culturally responsive pedagogies in rural communities of largely Indigenous students (Lipka et al., 2013; Wagner & Lunney Borden, 2015; Nicol & Yovanovich, 2017). My study extends this research field to include culturally diverse urban classrooms. I draw upon my experience as a non-Indigenous Grade 7 teacher working in urban school communities within the Lower Mainland of British Columbia for my research design.

In North America, there is a tradition of place-based education that has developed with notions of experiential pedagogy (Dewey, 1907; Casey, 1997), student well-being (McBride, Brewer, Berkowitz & Borrie, 2013, North American Montessori Centre, 2008; Louv, 2005) and protecting ecological systems (Lupinacci, 2013; Orr, 1992; Sobel, 2004). Articulation of critical pedagogies of place (Greenwood, 2013) has brought a sensibility of relational ethics and responsibility for the future through historical consciousness to place-centred education. This movement in mathematics education relating with place provides reference points for my study. As well, recent studies of Indigenous practices of working with place in mathematics education are significant guides for my research. Examples include: educational research and accounts of Polynesian ocean star navigation (Furuto, 2014) and the study of relating mathematical design and the ceremonial significance of a Blackfoot medicine wheel site (Stereberg, 2013).

Issues of power, agency, and identity in mathematics education (Gutiérrez, 2013, 2018; Gutstein, 2006; Walls, 2006) fuel my desire to focus this study on teachers' voices and their storied experiences. Gutiérrez (2018) shares ways in which not only students but also teachers may experience school structures as dehumanizing. Teachers that she spoke with described not being able to express their cultural identities, having to follow arbitrary rules, and feeling interchangeable as dehumanizing. I have experienced a dehumanizing feeling of being interchangeable when at one point in my teaching career I was laid off from my position of classroom teacher. I was immediately replaced by a different teacher and then later reassigned to another school community. The work and time of building relationships with my original school community were not acknowledged or considered. I see an opportunity in this study of mathematics education to listen to teachers as experts of relating to community and place with the awareness of issues of power, agency, and identity for teachers, students, and other school community members.

1.3 Research Design

1.3.1 Methodology and conceptual framework

I have chosen to use narrative inquiry as a research methodology for this study. As a branch of qualitative research methodologies it values human experience and provides an alternative to strictly positivist research paradigms (Clandinin, 2006, p. 44). Valuing teacher experience in this educational research allows for possibilities that can only emerge from the details of daily practices.

Narrative inquiry is the study of experiences that includes conversation and collaborative creation of narrative research texts (Clandinin, 2013). It is aligned with a social constructivist

philosophy of education, “an approach to learning that holds that people actively construct or make their own knowledge and that reality is determined by the experiences of the learner” (Elliott et al., 2000, p. 256) in relationship to their community and world. As well, narrative inquiry as a methodology for this study follows a pragmatic sense of experience meaning that experience is viewed as continuous, temporal, and contextual (Clandinin, 2013; Clandinin & Rosiek, 2007; Dewey, 1938) .

Narrative inquiry is a relationally ethical approach to research. It respects the diversity of lived experiences and the agency of research participants. The notion of reality in narrative inquiry research is not pursued as something that can be found exclusively outside of the participants, but rather something that is negotiated through their living, telling, retelling, and reliving of experiences (Clandinin, 2013). The term ‘living’ in this research cycle refers to the practice of teachers in their classroom with students and school community. As the narrative inquirer, I become a part of the ‘telling’ of participant teachers’ experiences through our shared conversations. Constructing a research text, this dissertation, is the ‘retelling’. ‘Reliving’ occurs every time the participant teachers or the researcher (myself) re-enters their professional practices while reflecting on previous ‘telling’ and ‘retelling’ within this inquiry process.

1.3.2 Location and participants for this study

This study took place in the Lower Mainland of British Columbia on the traditional ancestral and unceded territories of the Coast Salish Peoples, including the Musqueam, Squamish and Tsleil-Waututh Nations. The seven teachers who agreed to participate in this study are all employed by the same district in the Lower Mainland. They work at five different schools in this public school district and hold teaching assignments that range from kindergarten through Grade 7. In this particular district, kindergarten through Grade 7 are taught in elementary schools.

Students attend Grades 8 through 12 in separate secondary schools. There are other districts in the province of British Columbia where students attend middle school for grades 5 through 8.

All of the participants in this study are classroom teachers, not specialist teachers. Along with teaching mathematics, they also teach the majority of the other school subjects. This has significance for this study as the participating teachers may reflect on their mathematics teaching experiences in comparison to or in conjunction with teaching other subjects. It also means that each teacher spends every day with the same group of students for the entire school year. The teachers' relationships with the students and their families have more time to develop than those of a mathematics specialist teacher who works with several different groups of students each day.

My three meetings with each of the teachers took place within the schools where the participating teachers work with the exception of two meetings. One of these meetings took place outdoors while walking along the Mamquam River just north of the Lower Mainland, and the other meeting took place in a coffee shop in an urban centre close to the school where the participant teacher works.

Two of the teachers participating in this study referred to their experiences teaching at an outdoor learning centre. All Grade 3, 4, and 6 students from the district where this study takes place go each year to the outdoor learning centre for a two- to five-day residential outdoor learning experience. Classroom teachers who accompany their students are expected to join the outdoor learning centre teaching staff in leading field studies or other outdoor activities.

1.3.3 My relationship to the community and place for this study

I have been employed by the public school district where this research takes place as a classroom teacher or a teacher-on-call since 2007. This is significant as it places me in two roles

during this inquiry, colleague to the participant teachers and university researcher. My long-term relationship with the district and community of teachers was helpful for the recruitment of teacher participants. As well, having knowledge of the contexts in which these teachers are practicing allowed our conversations to quickly become in-depth regarding their individual experiences. My intention for this study is to privilege the voices of the participating teachers. However, reflecting openly on my subjective role in the process is also a key part of this research project.

My ancestry is fifth generation European settler. My professional experience in relation to Indigenous education includes filling the roles of school-based Indigenous literacy teacher and district Indigenous education representative to the provincial teachers' association. This doctoral study builds on my master's research focus of engaging with Indigenous perspectives as a non-Indigenous person. For my master's capstone project I wrote about my experiences as a Grade 7 classroom teacher while collaborating with Tsleil-Waututh Nation education colleagues to teach painting and weaving centred around local Indigenous traditions and ontologies (Fritzlan, 2017).

1.4 Dissertation Outline

This dissertation is organized into a seven-chapter structure. The Introduction, Literature Review, and Methodology chapters provide a foundation and set the stage for this study. The Literature Review and Methodology chapters have been outlined briefly in the preceding sections of this Introduction chapter under the headings *Getting to Know the Research Landscape* and *Research Design* respectively.

Chapters Four through Six present the findings from each of the three phases of data analysis. Chapter Four presents the conversations that I had with teachers in the form of

Individual Narratives, one for each of the seven participating teachers. The Individual Narratives were co-composed in consultation with the teachers. They are a retelling of our meetings based on data collected including: audio recordings, transcripts, field notes, emails, and phone conversations. A second phase of data analysis resulted in the identification of narrative threads that are common to multiple Individual Narratives. These Resonant Narrative Threads (RNTs) are presented in Chapter Five. The sixth chapter of this dissertation provides a venue for recognizing narratives of the institutional and broader social conditions of the teachers' lives as reflected in the data and previous findings of this study. I identify and focus on three 'sites of negotiation' between dominant narratives and counter narratives: *Who can do math?*; *What counts as elementary school mathematics?*; and *Relationships with place through mathematics education*. The third phase of analysis involves not only rereading the Individual Narratives and the RNTs but also engaging with related popular media and research literature. The exploration of dominant narratives and counternarratives leads to the consideration of a third narrative pathway at each of the three focal 'sites of negotiation'. These third narrative streams illustrate the significance of reflecting on teaching mathematics in relationship to self (as a teacher), engaging with cultural histories of school communities, and the agency of place in mathematics education.

Finally, in the concluding chapter of this dissertation, I outline how the findings of this study address the primary research question. As well, I describe the ways in which this study contributes to previous research in mathematics education, and offer recommendations for further research. In the final section, I reflect on where this study began and my experiences and findings along the way, following the notion of 'reliving' as a part of the cycle of narrative inquiry (Clandinin, 2013).

CHAPTER 2: LITERATURE REVIEW

The following literature review is a conversation with established research and ideas that are relevant to this study's purpose: to inquire into the ways in which public elementary school teachers' attend to relationships with community and place through their mathematics teaching practices. My research topic is built on an assumption that mathematics education is a socio-cultural endeavour and that it reflects particular worldviews and perspectives at any given time or place. This study also works with an assumption that place plays a role in human relations and therefore in mathematical thinking and practice.

There is a considerable body of recent literature that addresses cultural connections for mathematics education. This field of culturally responsive mathematics education (CRME) forms the theoretical reference for my study. I also draw upon recent studies in critical mathematics education (CME) (Frankenstein, 1983, 2015; Gutstein et al., 1997; Gutiérrez, 2013, 2018) for the analysis and discussion of my research data. Educational research that gives attention to relationship with place in mathematics education is the topic for the third area of focus in this literature review.

Much of the research discussed in this review is implicated in all three of the sections that I have outlined (culturally responsive mathematics education, critical mathematics education, and place-based education). However, the division into three sections creates a framework based on my interests for this study and around which to notice movement in research over time, how conversations of educational studies influence and borrow from one another, and the gaps and weaknesses that call for additional study. This review is not meant to represent the whole of the field of mathematics education in relationship to community and place. I chose specific examples of research to highlight based on their relevance to my own research aims. My intention is to

give attention to and develop notions of curriculum as complicated conversations in education (Pinar, 2012) rather than simplify by reductive summary.

2.1 Culturally Responsive Mathematics Education

2.1.1 Mathematics as a cultural practice in education

Ernest (2018), in his overview of the philosophy of mathematics education, identifies a controversy between traditionalist mathematicians claiming “that mathematics is certain, cumulative and untouched by social interests” (p. 17) and social constructivists who “argue that mathematics is fundamentally social, with cultural limitations to its claims of certainty, universality and absoluteness, and is as much subject to conceptual revolutions as is science” (p. 17). This study adopts the position that mathematics is socially constructed and culturally shaped. Taking this assumption into a study of the practice of teaching and learning mathematics complicates the cultural dimensions of mathematics through the interactions between participating students, teachers, institutions, communities, and places. It asks the question, Whose culture is being practiced in mathematics education?

There is widespread acceptance of Bishop’s (1988) theory of six universal categories of cultural practices that may be considered mathematical: counting, measuring, locating, designing, playing, and explaining. Bishop’s theory is published in the recently revised British Columbia provincial mathematics curriculum for all elementary, middle, and secondary grade levels as a digital link to “Incorporate First Peoples worldviews and perspectives to make connections to mathematical concepts” (British Columbia Ministry of Education, 2016, <https://curriculum.gov.bc.ca/curriculum/mathematics/4>). Opening a conversation of all the mathematics referred to in the lines of the provincial curriculum as culturally linked is not made

explicit by this placement of Bishop's theory. Rather, in this context, culture is connected to mathematics in the context of Indigenous peoples. My research aims to address this gap in conversation of all mathematics as culturally contextual.

For the purposes of this study, I believe that it is important to understand the development of Bishop's widely accepted theory. Bishop (1988) draws on L. A. White's book *The Evolution of Culture* published in 1959 to reason the conception of mathematics as culturally determined. White (1959) describes that "the functions of culture are to relate man to his environment on the one hand, and to relate man to man, on the other" (p. 8). Bishop (1988) adopts this conception of culture and the four components that make up culture as explained by White (1959): ideological, sociological, sentimental, and technological. Technology is identified as the basic component that determines the content and form of the other three (p. 182). Bishop argues that the technological aspects of mathematics in the form of symbolism offer a chance to explore the ideological, sentimental, and sociological aspects of culture. In other words, the language and tools used to express mathematics are cultural. He concludes that mathematics may therefore be conceived as a "cultural *product* which has developed as a result of various activities" (p. 182).

Bishop (1988) reflects on his own position in claiming his six culturally linked mathematical activities as universal: "There is no real prospect of *my* being able to test whether or not this 'universal' structure will be adequate for describing the mathematical ideas of other cultural groups" (p. 184). He further states, "I believe it is important to recognise that in this kind of analysis one must be constantly aware of the dangers of culturo-centrism" (p. 182). He raises the issue of differences in symbolization and values in the mathematics developed by different cultures (p.187). He claims, "Just how great these differences are will have to be revealed by further analysis of the available anthropological and cross-cultural evidence" (p. 187).

Bishop (1988) lists the values attached to Western mathematics as: rationalism, objectism², control, progress, openness, and mystery. Mathematics education that does not pay attention to the associated cultural values is described as merely “training” (p. 181). Bishop also questions for whom Western mathematics will be enculturation (learning of one’s own culture) as opposed to acculturation (assimilation into a different dominant culture) (p. 187). Two decades later, Bishop (2012) laments the lack of research of values in mathematics education. He argues for “value education in mathematics” (p. 7) and the responsibility of educators and researchers “to ensure that the values of learning mathematics are not felt negatively by the young students of today” (p. 8).

Considering “whether mathematics is value-laden or value-free” introduces a philosophical question: “Is mathematics ethically neutral or does it bear ethical responsibility for its role and uses in society and education?” (Ernest, 2018). The definition of values may be expressed philosophically as epistemological and ontological and “composed of three dimensions: prizing, acting on one’s beliefs, and choosing one’s beliefs and behaviours” (Ernest, 2016, pp. 190-191). Inquiring into social and cultural values reflected in mathematics education is a significant goal for my conversations with teachers participating in this study.

In the time since Bishop’s initial (1988) claim of mathematics as a cultural phenomenon, mathematics education researchers working with attention to culture continue to articulate the connection of culture and mathematics in a variety of ways. Examining mathematical thinking and ways of being that are particular to a cultural community defines the field of

² Bishop (1988) uses the term ‘objectism’ to describe an ideology related to a Western cultural worldview obsessed with objects and technology. He writes: “One of the ways mathematics has gained its power is through the activity of objectivising the abstractions from reality. Through its symbols (letters, numerals, figures) mathematics has taught people how to deal with abstract entities *as if they were* [emphasis in original] objects” (p. 186).

ethnomathematics (D'Ambrosio, 1985; Carraher, Carraher & Schliemann, 1985; Walls, 2006). I will discuss ethnomathematics further in an upcoming section of this chapter.

Gutstein and colleagues (1997) are critical of developmental theories that compartmentalize cognition from culture in their studies of mathematics and social justice with urban Latino communities. They assert that culture can be defined as “ways in which a group of people make meaning of their experiences through language, beliefs, social practices, and the use and creation of material objects” (p. 712). Walls’ (2006) study of ethnomathematics in the South Pacific includes ontological elements, “embedded ways of being” (p. 2) in reference to culture. Wagner’s (2014) discussion centred on democracy in a multicultural educational setting works with the notion that mathematical ontologies and epistemologies are defining elements of culture. The work of Gutstein (1997), Walls (2006), and Wagner (2014), along with that of other educational researchers, will be discussed further in the following sections.

2.1.2 Studies in culturally responsive mathematics education

My study aims to further mathematics education research that gives attention to and privileges local culture and places with an emphasis on relationship, collaboration, and collective space in the development of culturally conscious mathematics teaching and learning. A synthesis of local and distant research surrounding CRME provides insights for this inquiry. These research projects that I include share an understanding of mathematics as being connected to culture and a concern for culturally marginalized students who historically have had difficulty engaging with and pursuing mathematics education. However, the discussion of mathematical cultural links within these studies is broad and diverse, as are the social and political issues that emerge.

Culturally responsive education is described by Nicol, Archibald & Baker (2013) as:

an approach to teaching and learning that facilitates critical consciousness, engenders respect for diversity, and acknowledges the importance of relationship, while honouring, building on, and drawing from the culture, knowledge, and language of students, teachers, and local community. (p. 76)

Culturally responsive pedagogy “is rooted in relationships and places” (Nicol & Gerofsky, 2009, p. 111). It “is often aligned with more critical and radical forms of multicultural education, as it moves beyond a focus on academic achievement and attempts also to enact educational transformation” (Nicol, Archibald & Baker, 2013, pp. 74-75). CRME bridges mathematics and culture (Nicol, Archibald & Baker, 2010, p. 6) in relationship to place and community.

Using participatory action research methodology, Nicol and colleagues (2013) collaborated with educators and Indigenous community members in the North West of British Columbia to approach mathematics education through story. Recognizing issues of students’ doubt, fear, exclusion and anger in mathematics classrooms, this particular group of educators and researchers was interested in finding a way to create emotionally safe spaces that were comprised of “trust, respect, listening, inclusiveness, risk taking, acceptance of difference, caring, co-operation, and hopefulness” (p. 80). This attention to the emotional landscape and the collaborative work approach led to a desire by both Indigenous and non-Indigenous participants to learn more about local Indigenous culture.

In the context of group meetings with storytelling, a local Indigenous story, *Raven Brings the Light*, was agreed upon as a focus for their mathematics inquiry. Nicol and colleagues (2013) write,

Teachers together with community members brainstormed ideas for mathematical and cultural investigations including problems for comparing surface areas and volumes of nested boxes, building nested boxes from paper, and exploring the

concept of transformation and shape-shifter from a mathematical sense and cultural sense (e.g., Raven as shape-shifter). (p. 80)

This collaborative research approach emphasizes the sometimes complicated and time-requiring work of building relationships in their local community for non-Indigenous educators or educators from another place (p. 84). A hope that I hold for my research outcomes is to shine light onto the often unacknowledged work by teachers to build relationships with communities over the span of their careers and the complexities of building relationships between teachers and local Indigenous communities in particular.

Lipka and colleagues (Lipka et al., 2015) provide another example of CRME education research built on long-term relationships and a collaborative ethic. Lipka and colleagues have worked for over 30 years with Yup'ik community members and educators in the Alaska region to articulate mathematical practices embedded in everyday tasks needed to survive. They write that “Yup'ik people are generalists; individuals have needed to make clothing, build houses, fish racks, smokehouses, and kayaks, and orient themselves in various weather conditions when traveling on the tundra, in forests, and on rivers and open seas” (p. 3). A goal of their research and educational practices is to look for the mathematical concepts behind these Yup'ik traditional tasks.

Yup'ik geometric construction that starts with centre corresponds with Yup'ik cosmology (Lipka et al., 2015). Their communities are focused around a central community house, *qasgiq*. The *qasgiq* “is not only the physical center of the community; it also represents life cycles within life cycles, how from birth to death and through naming the newborn after the dead, the cycle continues” (p. 161) This notion of focusing on a centre has been described as looking to “the beginning of everything”. In a practical sense, when used to make clothing, this ontological

stance translates to every length and line segment having a centre, a folding point to create two symmetrical halves (Lipka et al., 2015, p. 5).

Mathematics embedded in Yup'ik cultural practices and skills are being used as supplementary materials in classrooms in Alaska and have resulted in improved performance of Native and non-Native students (Kisker et al., 2012). Symmetrical folding used in Yup'ik sewing has been used in workshops with teachers. Folding material into symmetrical halves works with a base-two model of mathematics, creating two, four, eight, etc., equal parts, creating a method for teaching fractions. As well, folding into thirds, which is also used in Yup'ik sewing, extends prime folding practices (pp. 173-175).

Working with Mi'kmaw communities in eastern Canada, researchers Wagner and Lunney Borden (2015) write about CRME. In one of their studies, they identify a difficulty that exists for secondary students. Wagner and Lunney Borden describe reciprocal rejection by Mi'kmaw students of both the dominant and their own marginalized culture in the context of mathematics education. Wagner and Lunney Borden explain, "when a dominant culture positions a community in a way that marginalizes the people, the people in that community, in their response, may comply with that marginalization by resisting engagement with the domineering organizations and people" (p. 115). To address the disconnect between dominant mathematics educational culture and marginalized Mi'kmaw students, the researchers engage in mathematical conversations with Mi'kmaw elders (p. 115).

Wagner and Lunney Borden's (2015) conversations with elders inspired an ongoing mathematics education event called the Show Me Your Math (SMYM) contest in which students investigated their own ethnomathematics. In this work, Wagner and Lunney Borden (2015) are recognizing Mi'kmaw practice of learning from elders, of passing on tradition. They are also

engaging in the complexities of relationship between people who have lived in a place for a long time and contemporary dominant cultures.

Wagner and Lunney Borden (2015) acknowledge the difficulty of defining mathematics that is relevant to all cultures. They also recognize the danger of researching ethnomathematics based on how it resembles traditional Western mathematics (p. 116). There is no Mi'kmaw word for mathematics. The identification of Mi'kmaw cultural practices as mathematical had to come from definitions within the discipline of mathematics. Furthermore, they explain how being defined as mathematical had no relevance for the cultural value of a particular cultural practice (Wagner & Lunney Borden, 2015, p. 117). For their study, Wagner and Lunney Borden made use of Bishop's (1988) proposed universal categories of cultural activities that create mathematical thinking or knowledge: "counting, locating, measuring, designing, playing, and explaining" (p. 182-183).

Through their conversations with elders, Wagner and Lunney Borden (2015) have identified cultural values of common sense and necessity that are part of traditional and current Mi'kmaw practices. Personal needs and the needs of the community ground these cultural practices. Wagner and Lunney Borden describe how for the Mi'kmaw elders the value of common sense was connected to survival. Common sense was sometimes in conflict with conversations of school mathematics. For example, when talking about measuring, common sense about water was discussed. The elders commented on how turning on the tap to get water could lead to taking water for granted. An appropriate amount of water to use was based on common sense of making sure that there was enough left for future generations (p. 120).

Wagner and Lunney Borden (2015) explain that "Mi'kmaw culture strongly values awareness and connections to the land and to each other, which are connections that can be lost

in the abstraction that is often associated with mathematics” (p. 123). Common sense is a form of resistance against culturally disconnected abstraction in school mathematics. Common sense considers what is appropriate in relationship to land, people who live with the land, and generations to come. Through the Mi’kmaw elders’ knowledge of common sense, relationship with the land is passed on. This different sense of time, of learning from those who have lived with the land for a long time, is a way of becoming culturally responsive in mathematics.

The students of the Mi’kmaw community are caught between culturally valued common sense and school mathematics. Students’ success in the abstract mathematics of school is necessary for higher education which brings needed skills into the community (Wagner & Lunney Borden, 2015). Wagner and Lunney Borden recommend using necessity as a guide for bridging common sense and mathematics. They propose two questions for mathematical experiences: “First, what does a task necessitate the student doing?”; “Second, what mathematics is the student doing when addressing these necessities?” (p. 125). For the SMYM event, students made connections between their own cultural traditions and abstract mathematics. They interviewed and worked with elders to learn traditional cultural practices that they could then connect with mathematics. An example of this is investigating cultural practices necessary for survival or functionality such as building traditional canoes or weaving baskets that could be connected to mathematics through design (p. 125).

The researchers look to the elders who hold knowledge of traditional ways of surviving with the land and are “forward thinking”, always considering generations to come (Wagner & Lunney Borden, 2015, p. 120). This bridging of Mi’kmaw culture and school mathematics is also working with two different conceptions of time, one grounded in particular relationships with land, and one that is abstract and universal. This follows Mi’kmaw principle of two-eyed seeing

expressed by Mi'kmaw elders Murdena and Albert Marshall (Bartlett, Marshall & Marshall, 2012). Two-eyed seeing allows a weaving back and forth between Indigenous knowledge and Western science for the benefit of a particular circumstance (p. 334). It is the circumstance, the needs and future needs, of communities and land that shapes the approach.

Relaxing academic discipline boundaries is another theme that emerges in this discussion of CRME. Teaching across disciplines makes possible mathematical education that is not limited to Bishop's (1988) categories (counting, locating, measuring, designing, playing, and explaining). What about imagining, intuiting, dreaming, singing, and storying? The story of *Raven Brings the Light* is the starting point for an inquiry into mathematics education with local traditions for educators in the North West of British Columbia working in collaboration with researchers Nicol, Archibald, and Baker (2013). Traditional Yu'pik ways of making clothing is a method of mathematics education for Lipka and his colleagues (2015). I argue that continuing research that considers cultural practices and values as part of mathematics education is necessary for respectful, and appropriate relationships between schools, teachers, and learners in education and that this means being aware of epistemological, ontological, and cosmological restrictions in a siloed version of mathematical thinking and practice.

Indigenous self-determination in education involves a recognition of the potential danger of academic disciplines. Māori scholar Smith (in Smith, Tuck & Yang, 2018) writes,

Understanding the nature of academic disciplines and their underlying philosophies and methods has helped me deconstruct the power of disciplines to define and represent Indigenous peoples and our ways of knowing and being, and to entrap us in their sense of reality. A decolonizing agenda has to help Indigenous peoples to create and revitalize our own frameworks, language, theories, methodologies, and practices that work for us. (p. 7)

Attention to Indigenous practices in mathematics teaching and learning that embrace interdisciplinary pedagogies is part of my inquiry. As a non-Indigenous educator and researcher,

I recognize the importance of working to uphold Indigenous self-determination while becoming aware of my own complicity in ongoing colonizing practices. This ethic informs my conversations with participating teachers.

Research bridging Indigenous culture and mathematics education has primarily explored culturally responsive pedagogies in rural communities of largely Indigenous students (Furuto, 2014; Lipka et al., 2013; Nicol, Archibald & Baker, 2010; Nicol & Yovanovich, 2017; Sterenberg, 2013; Wagner & Lunney Borden, 2015; Walls, 2006). My study extends this research to include culturally diverse urban classrooms.

2.1.2 Ethnomathematics in education

D'Ambrosio (1985) defines ethnomathematics as the practice of mathematical thinking particular to a cultural group. Examples of research in the field of ethnomathematics include: studies of stick charts for ocean navigation in the Marshall Islands (Ascher, 1995); examination of computation methods for street-based sales by children in Brazil (Carraher, Carraher & Schliemann, 1985); and writing on Euclidian geometry in basket weaving and craft techniques traditionally used in Mozambique (Gerdes, 1988).

Vithal and Skovsmose (1997) offer a critique of ethnomathematics in the context of South Africa where Westernization of mathematics education was linked to industrialization and technology. They write, “ethnomathematics can be interpreted as a reaction to the cultural imperialism which is built into modernisation theory” (p. 132). In South Africa, the prefix ‘ethno’ is problematic. Used in ethnomathematics, it “does not assist in resolving the uncomfortable reference to ‘race’ but rather deepens it” (p. 138). As well, the authors discuss the dilemma or paradox of trying to identify mathematics that is different from conventional mathematics from within the frame of conventional mathematics (p. 141). Vithal and Skovsmose

support the development of a critical mathematics that focuses on social and political aspects (p. 152).

I am interested in research of ethnomathematics in the context of education and how it is related to or overlaps with research in CRME. What distinguishes ethnomathematics education from CRME? In this study, I engage with mathematics education that is culturally responsive in a culturally diverse student context. Teachers may not be able to create mathematics lessons that are culturally responsive to all of the students. By responding to some of the students' cultural perspectives in mathematics thinking, teachers may be introducing new cultural perspectives to other students. These are issues that apply to my study of mathematics education that is attentive to relationships with community and place in culturally diverse context.

The research of Walls' (2006) and of Furuto (2014) examine how ethnomathematics is considered in a school-based educational context. Walls' (2006) ethnographic research with schools in the South Pacific Islands and Furuto's (2014) research with the Ethnomathematics Institute at the University of Hawai'i at Mānoa both offer insights into researching mathematics education with local Indigenous communities that are marginalized within their local public school systems.

In her studies of mathematics education in the South Pacific Islands, Walls (2006) adopts an ethnomathematical view of interwoven "ways and means" that mathematics is constructed socially and transferred between generations. She writes: "there are highly developed life wisdoms to be found in the Pacific such as anatomy-based counting systems, oral methods of recording relationships and genealogies, accurate navigation across vast stretches" (p. 3). Walls (2006) also notes that for families in the South Pacific Islands, shifts in local economics to reliance on global capitalist systems affects local culture: "Success in school mathematics

examinations was widely regarded by Pacific Island parents and teachers as the gateway to children's overall success in education and a key determinant of future employment" (p. 3). Like Gutstein and colleagues (1997), Walls advocates for involving community and culturally based ways of knowing into the mathematics teaching. She asks, "How much of the world outside is carried into the classroom?" (p. 5). She is particularly concerned about the gap between informal math involving play at home within South Pacific contexts and Western mathematics at school. This conversation speaks to the contemporary realities of culturally situated knowledge and ways of knowing in relation to economic needs for survival.

During her research, Walls studied photographs of children and classrooms to find ways that mathematics is socially constructed and embedded in cultural practices through discursive processes (p. 2). Walls describes discursive practices as "both *constructions* of, and *constructive* of socially negotiated realities" (p. 2). Discursive practices in the Western mathematics taught in the South Pacific Islands are distinctly Western; they include structured lessons, work defined as providing answers, symbolic written communication, textbooks, English language, school buildings, and school management (p. 3). Walls asserts that the difference between South Pacific Islanders' epistemological and ontological principles of interconnection and a Western mathematical epistemology of universal principles and logical progression reduces school mathematical education to a "process of initiation" (p. 4). Her work contributes not only to the field of ethnomathematics in educational research but also to the field of critical mathematics education (CME), specifically the stream of CME that adopts Foucault's theory of social discourse. I include an in-depth discussion of CME in the next section of this literature review.

Referencing Bishop's (1988) list of culturally linked activities of mathematics, Walls (2006) gives an example of significant mathematical thinking that happens outside of school for

a South Pacific Island child in the act of playing. She describes a child's creation of a design of collected items, an activity that involves "comparing, sorting, grouping, connecting, patterning, aligning, shaping, and covering space" (p. 4). Walls is critical of the ways in which there has developed "a schism between school and non-school mathematics". She emphasizes that "school mathematics not only fails to connect with the world of the child, but also fails to connect with the geographical surrounds into which it has been introduced" (p. 4).

Walls (2006) advocates for involving community and culturally based ways of knowing into the mathematics teaching. She is particularly concerned about the gap between informal math involving play at home and Western mathematics at school. She points out that students perceive mathematics as alien if they cannot culturally recognize or find meaning in it (p. 4). An example that she gives of a student taking learning from school to his outside world through expressing mathematics by marking with a stick in the sand prompts Walls to ask "how much of the world outside is carried into the classroom" (p. 5).

Walls (2006) work is important to this study in its acknowledgment of the role played by culturally specific methods of teaching, including language, interactions of bodies, and the environment. Culturally specific methods of teaching are not as easily incorporated into curriculum documents as culturally specific knowledge and yet are as important. Culturally based-knowledge may rely on methods and protocols for education. Examples of this will be discussed as examples of CRME research.

Furuto's (2014) study of ethnomathematics in education originates in Hawai'i at the Ethnomathematics Institute, a place that supports the professional development of teachers. Furuto sees a need to address contemporary realities of significant cultural diversity in the US and more specifically Hawai'i through equitable education. She claims that "there is a growing

need by scholars and practitioners for teaching practices that are informed by cultural knowledge possessed by students” (p. 111). About ethnomathematics, she writes: “the goal is to acknowledge cultural systems and frameworks that have existed since the beginning of time and to help educators discover pathways that foster student engagement through conceptualizing and supporting new approaches to learning mathematics” (p. 113). Ethnomathematics in this context refers to mathematics connecting to the traditions of the Pacific Islands original peoples, those of “Hawai‘i, Guam, Samoa and other Pacific Islands” (p. 111).

The Ethnomathematics Institute, currently called the Ethnomathematics and STEM Institute, is affiliated with the University of Hawai‘i at Mānoa (University of Hawai‘i, 2017). It runs a professional development program for educators consisting of a series of orientation and professional development workshops and a one-week summer institute (Furuto, 2014, p. 115). Participants create and implement mathematics lesson plans following a pedagogy and practice that reflect the cultural values and traditions of the populations they work with. They are guided by the following principles: “(a) navigation (vision, exploration, education); (b) honouring elders (tradition, heritage, family, our first people); (c) environment (our sacred earth); (d) island living (our Pacific ‘ohana and multiethnic community’)” (p. 114).

In my reading of ethnomathematics research, I have found that cultural context and histories shape the meaning of the term ethnomathematics. Walls (2006) addresses Western power in mathematics education in the South Pacific that takes the form of dominant discourses including language and actions. I argue that once educators are convinced of the relationships between culture and mathematics inside and outside of formal education, awareness of the dominance or marginalization of different culturally based ways of mathematical thinking and practice necessitates a relationally ethical approach to teaching with diverse communities. This

notion of ethics of relationship in mathematics teaching and learning across cultural differences extends to researchers as well and exposes one of the limits of this study. This study privileges the voice of teachers on the topic of teaching mathematics to culturally diverse communities of students. However, the teachers, in most instances, are not members of the specific cultural communities that they teach in or with, and there are no participants in this study with Indigenous ancestry.

During the time of my doctoral studies, I was employed as a graduate research assistant by my doctoral supervisor, Dr. Cynthia Nicol, and was assisting in editing the manuscript for the book *Living Culturally Responsive Mathematics Education with/in Indigenous Communities* (Nicol, Archibald, Glanfield, & Dawson, 2020). As part of this assignment, I was given the task of finding updated information regarding a chapter for the book authored by the late Dr. Sandy Dawson and members of a few participants of Project MACIMISE (Mathematics and Culture in Micronesia Integrating Society Experiences). For the project MACIMISE, 22 participating graduate students from Hawai'i and nine Pacific Islands affiliated with the United States carried out research projects in mathematics education that reflected their own cultures (Dawson et al., 2020). The goal of Project MACIMISE was specifically to facilitate a process of “recapture of local mathematical thought and its transformation into school curricula” carried out by “individuals who came from the places they studied” (p. 176). I include this project here as a contrast to previously discussed studies of mathematics of a specific cultural group by researchers who are not from that cultural group. As university masters and doctoral students, the Project MACIMISE participants designed and carried out their own research projects on teaching mathematics with their own perspectives as Indigenous people. In an email communication that I had with one of the participants, she expressed the significance of the project for her:

This project has opened my mind and my heart to gaining a deeper appreciation for my culture and the intelligence behind my ancient ancestors. Often we think of our ancestors being more primitive and less intelligent than we are, however I now know this to be false as evidenced in the technology they used to build our latte homes, to navigate the seas, and to find food for themselves. (D. Muira, personal communication, June 1, 2017) (pp. 186-187)

It should be noted that Dr. Dawson, who is of non-Indigenous ancestry, was in a supervisory role for the Project MACIMISE participants and his perspectives shaped their success in their graduate programs at the University of Hawai'i at Mānoa.

2.1.3 Culturally pluralist mathematics education

Culturally pluralist mathematics education is another field of research that overlaps with CRME. Studies in culturally pluralist mathematics education are particularly relevant to my study that considers a multicultural context as well as non-Indigenous teachers experiences of responding to the British Columbia Ministry of Education's directives to incorporate Indigenous worldviews and perspectives into their lessons.

Averill, Anderson, Easton, Te Maro, Smith and Hynds' (2009) focus their research on student teacher experiences in a bicultural approach to mathematics education in New Zealand. Bicultural relationships between immigrants to New Zealand — European and subsequent — and Indigenous Māori is historically rooted in the 1840 Treaty of Waitangi and reflected more recently in the Ministry of Education's policies of 1993, 2004, and 2007 (p. 158). Averill and colleagues' research endeavours to “model with integrity ways that cultural perspectives such as active partnership and the use of the Indigenous New Zealand Māori language, pedagogies, contexts, beliefs, protocols, and values can be ‘woven’ into the preservice teachers’ own teaching” (p. 157). A key finding in their study is that student teachers need to spend time to understand culturally responsive strategies in the mathematics education courses. Their

recommendation is for cross-program “core cultural competencies” approach or a dedicated course (pp. 180-181).

Aikenhead (2017) advocates for an updated Canadian mathematics curriculum that reflects the cultural groups it serves. He recommends a culturally pluralist approach based on mathematical knowledge systems “developed historically in specific cultures” (p. 34). He describes the dangers of privileging a purely objective, value free, and universalizing Platonist view of mathematics in education that “ossifies privilege blindness” (p. 29). The author also warns of the neo-colonizing impact of contextualizing school mathematics in Indigenous cultures (p. 14), of superimposing Euro-American concepts overtop of Indigenous knowledge, and of homogenizing cultural perspectives and identities of any Indigenous group (p. 2).

Blackfoot scholar Little Bear (2000) writes, “culture comprises a society’s philosophy about the nature of reality, the values that flow from this philosophy, and the social customs that embody these values” (p. 77). He explains that “different ways of interpreting the world are manifest through culture” (p. 77). He also claims that “one of the problems with colonialism is that it tries to maintain a single social order by means of force or law suppressing the diversity of human worldviews” (p. 77). Writing from the perspective of a North American Indigenous person, he describes how Indigenous groups assume a diversity of individuals. A culturally pluralist approach to mathematics education challenges the singular Western colonizing approach that Little Bear describes. In the examples above, educators and researchers are promoting an idea of responding to more than one specific worldview through curricular policy.

Curriculum scholar Santos (2014) proposes the theory of ecology of knowledges in his writing on education in South America. This is a conceptual shift that assumes there is no complete knowledge system but instead human beings can create a plurality of knowledges that

is interdependent. His work emphasizes the relational aspect of knowledge. He writes, “The ecology of knowledges assumes that all relational practices involving human beings, and human beings and nature entail more than one kind of knowledge, thus more than one kind of ignorance as well” (p. 188). Cognitive justice, according to Santos, necessitates “raising the consciousness of such a reciprocal incompleteness (rather than looking for completeness)” (p. 212). As I focus on the relational in this inquiry of mathematics education, Santos’ theories contribute a method for thinking about the ways that power, agency, and identity in social relationships are wedded to ideas of particular systems of knowledge, complete or incomplete.

When mathematics in schools is set up as a competitive event through testing and ranking using an imposed universalized knowledge system, this sets up a system of seeing deficits in students. Further, Ojibwe scholar Bang and her colleague Medin (2010) describe how “a narrow focus on Platonist content achievement leads to: a deficit approach to school mathematics, a neo-colonial pedagogy, and a false assumption that learning mathematics is an acultural process” (p. 1009). Notions of plurality of worldviews, knowledges, and ignorances speak to this oppressive practice. There are no high-stakes standardized tests in the public education system of British Columbia. However, it has been my experience as a teacher in relation to administering assessments that students are affected by the process of being directed to complete these assessments, especially when they feel that they are not successful and are being judged as deficient relative to a broad standard. An example of this is my experience of administering a Grade 6 numeracy assessment given by my school district. As well, the results communicated to the district Grade 6 teachers and principals do not reflect the particular strengths or values of the diverse communities that they assess.

An important point that Ruitenberg (2007) draws our attention to is the distinction between relativism and pluralism. Relativism is an attitude that anything goes. In a relativist community, differences exist, but are not morally accountable to others. Pluralism indicates a moral accountability to community and a commitment to ethical relationship.

Pluralism is the view that there is more than one set of values that is legitimate and worth pursuing, but not an infinite number. We might say that most of us show ourselves to be pluralists in our individual lives as we espouse a range of values, some of which are at odds with each other, such as justice and mercy. The question of pluralism is raised most often, however, about societies in which individuals and groups with different sets of values seek to cohabit. (p. 56)

A culturally pluralist education community would seek to live and work together with a robust co-existence of cultural differences encompassing values, ways of being, and knowledges. In a multicultural context, pluralist approaches to education engender an atmosphere of openness to other (including self as other) (Guillemette & Nicol, 2016) and offer possibilities for participant self-determination and collective learning.

2.2 Critical Mathematics Education

Research in the field of Critical Mathematics Education (CME) offers insights into the ways in which educators may become aware of issues of social justice that are at work in the educational systems they are a part of along with how mathematics may be taught as a tool with which students can recognize and challenge issues of social justice in their own lives or society at large. The goal of my study, to explore how teachers' relationships with community and place shape their mathematics teaching, does not directly align with a CME focus on sites of oppression and teaching for emancipation. However, literature surrounding studies in CME informs the conversations that I have with participating teachers.

I treat the concepts of CME and ‘mathematics education for social justice’ as synonymous for the purpose of this study, agreeing with Skovsmose’s (2016) assertion that these are “two largely overlapping educational approaches” (p. 2). Social justice issues of equity, access, agency, identity, and power in the context of mathematics education provide a language for analyzing relationships that teachers participating in this study may describe with students, institutions, and communities. Having background knowledge of the significant research done in this area allows me to: be conscious of social justice issues in my design of questions that will act as conversation prompts; be attentive to teachers’ storied experiences of practices of mathematics for social justice; and reflect in depth on what these conversations may contribute to or gain from the field.

I organize my discussion of CME into three sections of developing research that is relevant to my study. The three sections are: CME drawing upon the work of Freire; CME drawing upon the work of Foucault; and a theory of rehumanizing mathematics (Gutiérrez, 2018) through attention to identity, agency and power in education. There is some overlap of ideas and key researchers within these three strands of CME that have developed concurrently.

2.2.1 CME drawing upon the work of Freire

Many CME researchers and practitioners have adopted Freire’s (1970) notions of emancipatory education (Frankenstein, 1983, 2015; Gutstein, 2006; Gutstein et al., 1997; Peterson, 2015). Freire’s aim is to teach the tools of literacy to empower the learner to challenge oppression and inequity for themselves. For Freire, teaching for literacy means teaching people to read the world and articulate injustices and also to write the world, fighting against injustices. Critical mathematics theorists and practitioners understand mathematics to be a form of literacy that can be used as a tool or methodology for challenging oppressive systems. They extend

Freire's notions of reading and writing the world to reading and writing the world with mathematics. In other words, learning mathematics is necessary for decoding and analyzing how it is used in oppressive ways. CME empowers people to not only challenge oppressive systems but also to build new, socially just practices.

Freire's (2005) notions of "teachers as cultural workers" are interesting in the context of my study. I am inquiring into the ways in which teachers are experiencing cultural practices and issues of difference in their mathematics teaching. Freire writes "there is no *teaching* without *learning* [emphasis in original text]" (p. 31). And of teachers, he writes, "their learning lies in their seeking to become involved in their students' curiosity and in the paths and streams it takes them through" (p. 32). He promotes teaching as responsive to students and unassuming of authoritative knowledge.

I find Freire's (1970) articulation of the need for the oppressor to be in solidarity with the oppressed — to enter into the situation of the oppressed — both important and challenging. An example that I can think of in relation to my experience teaching elementary school mathematics is standardized tests. I am convinced that standardized tests have the potential to erode the mathematical confidence of some students. And yet, as a teacher, one has to choose to either administer the tests or risk job security. How could a teacher act in solidarity with students for whom they believe that standardized testing may not be beneficial and may even be detrimental? Dialoguing with families regarding the realities of standardized testing effects is one way to address this concern of teachers. However, this may be prohibited by school districts in some instances. Teachers are both oppressed and oppressors in this situation.

Frankenstein (1983) argues that concepts from Freire's 1970 text, "Pedagogy of the Oppressed," can be employed to "create an approach to mathematics that can lead to greater

control over knowledge and to critical consciousness” (p. 315). She is particularly concerned with a general lack of understanding “of the technical knowledge that is used to obscure economic and social realities” (p. 315). She identifies a practice of abandoning statistics “to the ‘experts’ because it is thought too difficult for most people to understand” (p. 315). Her work advocates for the study of mathematics and statistics in social sciences. This involves a process of humanizing mathematics in part by taking away both the mystery of mathematical processes and personal anxiety around performance in mathematics education.

Frankenstein’s (1983) critical mathematics research draws on Freire’s epistemology of knowledge as constantly being created and recreated by the reflections and actions of people. People are necessary subjects in this system, and knowledge is never static or contained by “abstract properties of objects” (p. 316). She applies these principles of knowledge to the study of teaching mathematics to working-class adults. Teaching analysis of statistics representing income and demographics to her students, Frankenstein works to “challenge students to reconsider their previously ‘taken-for-granted’ beliefs” (p. 331). As her students become literate in mathematics they may see the ways in which they are oppressed by the system and become empowered to take action for change. Frankenstein (1983) maintains that developing critical consciousness — what Freire (1970) terms *conscientização* — through a process of mathematics education empowers students of social sciences to overcome participation in their own domination.

Within my inquiry, critical consciousness can be a concept applied to the teachers with whom I converse. It can also be thought of as a method, or intention of the teachers for their students. I am curious to know if any teachers that I recruit for this study feel that they are participating in oppressive systems of education. I am also curious if any of the teachers feel that

there are ways that they are taking part in oppressive dominating practices in regards to their students and what strategies they might take to address these.

The idea of having students “own” their mathematical thinking and practice comes to mind for me as a way of countering dominant mathematics education systems that are not beneficial to students. Gutiérrez (2018) writes of there being no student misconceptions, only conceptions. The work of the teacher is to ask questions and try to understand the students’ conceptions. She argues that students conceptions may be misunderstood as misconceptions,

They are only “misconceptions” when we begin with the expectation that others need to come to *our* way of thinking or viewing the world. (Gutiérrez, 2018, p. 3)

Similarly, Frankenstein (1983) promotes a non-hierarchical view of dialogic interaction between educators and students as a guideline for critical mathematics. She explains that an educator’s task may be confused with teaching a student what to think but that students can already think. An educator’s task, she claims, is to exchange ways of thinking with students and to work together at the ways they can best decode the world using mathematics (p. 323).

Frankenstein (1983) highlights Freire’s (1970) idea of ‘massified’ consciousness in relation to mathematics. She writes: “people with massified consciousness understand that humans change and control the world. But they believe that each individual acts from rational free choice rather than from a complex interplay of choice and manipulation” (p. 319). Freire wrote of the “ruling class” as the dominating force. In this social dynamic, he asserts, illiteracy further oppresses those not in the ruling class and allows a process of social manipulation that serves the interests of the ruling class.

The notion of massified consciousness is extraordinarily pertinent to the conversation about mathematics and society today. It can be argued that the interests of corporations and those who benefit from corporate wealth are supported by a system of massified consciousness through

internet communications. Deciphering the boundaries between free will and coercion through online news, advertising, and other forms of online knowledge transmission is a current human dilemma — a dilemma that becomes all the more difficult as the difference between “real” and “fake” online information becomes less clear. The ways that teachers address this force of massified consciousness through mathematics teaching is part of my inquiry. I endeavour to better understand through this study whether and how teachers consider the elements of personal risk and of difference in their day-to-day interactions with students in the context of teaching social justice through mathematics. This includes their work teaching data and statistics.

In her more recent writing, Frankenstein (2015) describes mathematics education aimed at addressing how statistics and data are used to serve industrial capitalist and corporate interests. She also looks at how similar models affect measurement and value of the work of teachers. In one teaching example, she examines the practice of cost-benefit analysis used by corporations that: “put[s] dollar figures on values that are not commodities”; “downgrade[s] the importance of the future”; and “ignores considerations of distribution and fairness” (pp. 291-292). Cost as a concept that is more than just a monetized definition is also illustrated in a video that I have regularly shared with Grade 7 students, *The Story of Stuff* (The Story of Stuff Project, 2013). *The Story of Stuff* traces ‘costs’ that are hidden in the products we buy, not reflected in the monetary price to consumers, such as environmental pollution or unhealthy working conditions. This video also challenges corporate notions of “value” and of “cost” as singularly monetary.

Frankenstein (2015) argues for an interdisciplinary approach to teaching mathematics that considers social and political contexts. Learning about measuring the ‘real world’ with statistics and data goes beyond treating it as a backdrop for the mathematics. She writes: “The goal of the mathematics lesson is not therefore merely to practice a particular math skill; the goal is to use

the relevant math skills to understand public interest more clearly” (p. 293). By understanding the public interest issues more clearly, it follows, students will be able to take action for social justice.

I am particularly interested in Frankenstein’s (1983, 2015) interpretations of Freire’s concept of critical consciousness in the context of mathematics education. I appreciate her attention to how this concept translates to the current context of capitalist and corporate interests being served by obscuring mathematical language. As well, Frankenstein’s ideas of an interdisciplinary approach to teaching mathematics for social justice is relevant to my conversations with participant teachers who may also use an interdisciplinary or transdisciplinary culturally responsive approach.

Frankenstein (2015) also addresses her readers who are teachers in a critique of how labour is measured. She references a Marxist conception of “abstract labour,” drawing parallels to how teachers’ work may be quantified by the success of students on tests. The view of a mathematics teacher as a replaceable part of a managed system is a concept that I hope to challenge in my study by focusing on the relationships that teachers negotiate with students, schools, communities, and places. Frankenstein asks if the success of educators should take into account non-quantifiable labour including efforts to “integrate community activism and classroom teaching” and professional contributions “to the well-being of our community” (p. 302). I am interested in the work that teachers do with parents and other community members that students are connected to outside of schools. In my experience, building long-term relationships with these communities is work done by teachers that is not acknowledged by districts and schools.

Engaging in local social justice through mathematics education is likely to make direct links to events and circumstances in students' lives. This creates an opportunity for students to learn about or more deeply understand issues in their community and to play a role in advocating for change. Using global issues in mathematics classrooms as opposed to local issues may or may not have personal meaning for students. If the global issues do not connect directly to students' lives then students may simply be banking knowledge of social justice issues rather than assuming an active role.

Peterson (2015), an educator and researcher in the Milwaukee public school system, claims that when a teacher does “not include math problems that help students confront global issues” (p. 63) this is a political choice. Describing how he is witness to an oppressive system in which students are segregated by race and income, Peterson writes that he believes firmly in political activism as directly linked to education. This is a direct part of his life and community. He writes of a need to “join with parents and community partners” (p. 62) to foster development of socially conscious students who have the tools to act for social justice. Activism involves risk because it is challenging status quo and authority. How do students learn about their own assumptions of social privilege in relation to the risk of activism? This also relates to Freire's (1970) ideas of not being able to turn back and unsee oppression after it is uncovered. I understand that Freire is using this concept for situations experienced first-hand. I think that Peterson (2015) extends this concept to seeing oppression of other people too, invoking another discussion of personal responsibility to others and critical self-reflection.

Gutstein and colleagues (1997) research culturally relevant mathematics and CME in an urban Mexican American context. I am particularly interested in how they combine intentions of culturally relevant mathematics education and teaching mathematics for social justice. In my

own research, I am also considering the experiences of teachers within the fields of both of these distinct yet related approaches to mathematics teaching.

Like Frankenstein (1983, 2015), Gutstein and his colleagues (1997) also take a Freirean approach to teaching and learning, working with students to decode and recreate their worlds, in the context of mathematics. “A critique of unequal power relations in society and of the role of power relations in schooling” is central to their work (p. 714). They explicitly ask, “How does an “outsider,” that is, someone from outside the culture, who cannot “walk on the same path” become a culturally relevant teacher?” (p. 734) This leads to the question, What is the responsibility of a cultural outsider, one in a privileged position, to raise the position of those who are marginalized? Gutstein and colleagues’ goals are for both academic success of students and community engagement and social agency in mathematics teaching and learning.

In my own experience of teaching elementary school mathematics in an urban and culturally diverse classroom, I have struggled with the practice of helping students to succeed in a system of education that privileges gatekeeping testing of abstract, decontextualized mathematical skills. This is a dilemma that I reflected on in a personal story that I contributed for a collaboratively written article:

I see tensions in disrupting mathematics education practice that prioritizes abstract skills as being necessary to "keep up" or "get ahead" in our current system of competitive mathematics for higher education. I have been part of a team of teachers that placed an emphasis on training kindergarten to grade three students in abstract numeracy skills. This was rationalized as building a foundation for their future mathematics learning. At the intermediate level, grades four to seven, I have struggled with an urge to have students "catch up" with levelled expectations through similar abstract universalized math drills and teaching to standardized tests. (Nicol, Gerofsky, Nolan, Francis & Fritzlan, 2020, p. 11).

My struggle as a teacher has been to facilitate students’ agency in school mathematics through connections to their own socio-cultural worlds while at the same time explicitly

promoting their success in a universalizing system of assessment. While Gutstein and colleagues' (1997) context of teaching and research differs socially and politically from mine, the need to broaden the conversation of what meaning is attached to school mathematics content and the definition of student success is similar.

2.2.2 CME drawing upon the work of Habermas and Foucault

A second tradition of CME that I discuss draws upon Foucault's theory that human behaviour is determined by social discourse. Andersson and Barwell (2021) explain that within this branch of CME mathematics is viewed as a discourse that "plays a role in human affairs", the effects of which "may be largely unnoticed or even invisible" (p. 9). It follows that mathematics education is not a process benign process concerned with a neutral set of skills and facts. Participants are not aware of the underlying social assumptions created by the mathematical creation of categories, orders, and normalcy (for example, height) (p. 9). An example of mathematics as social discourse can be found in algorithms used for determining a person's suitability for a job. O'Neil (2016) exposes how the assumed just and objective nature of these algorithms that are not attached to human accountability in fact masks ethical biases of the people and environments that create the algorithms and market them for a profit.

CME drawing upon Foucault and CME drawing upon Freire share similar concerns for bringing together studies of mathematics and the humanities, including education. Skovsmose (2012) describes his early research goals to challenge the separation of mathematics and mathematics education from critical theory developed post World War II with the Frankfurt School. Skovsmose began his doctoral research in CME in 1977. At that time, critical education theorists following the work of Habermas (1971) considered knowledge in natural sciences and mathematics to be constituted by *technical* human interests whereas knowledge in social sciences

and education were determined by *emancipatory* human interests (Skovsmose, 2012, p. 39).

Critical theorists held a stance that opening social sciences (including education) to be theorized as knowledge constituted by technical interests threatened justification for social domination, and so, firmly rejected connections between mathematics and the humanities (p. 39). Skovsmose's doctoral research aimed to combine critical education that was applied to the humanities with mathematics education. He worked with cooperating teachers with the goal of finding ways of implementing a critical mathematics education (pp. 40-41).

The practice of critical education developed within the industrialized world as a way to question the assumption of the social and political benefits of industrialization and resulting systems of bureaucracy and capitalization (Vithal & Skovsmose, 1997). CME emerged as a way of developing a socially aware and politically responsible response to a purely technological view of mathematics education serving a modern view of progress that went hand in hand with industrialization (pp. 131-132). Foucault's discourse theory challenges a notion of scientific or mathematical certainty claimed in a notion of modern progress with the intent of exposing the underlying structures of social and political power (Skovsmose, 2011).

Vithal and Skovsmose (1997) support the development of a critical mathematics that pays attention to social and political discourse (p. 152). For example, they offer a critique of ethnomathematics in the context of South Africa where Westernization of mathematics education was linked to industrialization and technology. They write, "ethnomathematics can be interpreted as a reaction to the cultural imperialism which is built into modernisation theory" (p. 132). In South Africa, the prefix 'ethno' is problematic. Used in ethnomathematics, it "does not assist in resolving the uncomfortable reference to 'race' but rather deepens it" (p. 138). As well, the

authors discuss the dilemma or paradox of trying to identify mathematics that is different from conventional mathematics from within the frame of conventional mathematics (p. 141).

Skovsmose (2011) asserts that, while the distinction between phenomenon that the discourse about that phenomenon is blurred, there is real change in the ‘world’ that is different than discourse. However, he claims that specific preoccupations may be changed through change in discourse, and that this changes ‘lifeworlds’ (p. 1-2). Skovsmose writes:

I do not see critical mathematics education as a special branch of mathematics education, nor do I relate it to certain classroom pedagogy or particular curriculum content. Instead I see it as an expression of some preoccupations or concerns with respect to mathematics education. (p. 2)

He generally describes his view of mathematics education as “without ‘essence’” or “undetermined” but rather determined by socio-cultural and political systems (p. 2-3). His conception of CME exposes mathematics education to analysis of hidden socio-cultural and political agendas. Further, Skovsmose (2020) explains how the open nature of CME is due to the ongoing change of the issues or preoccupations that it addresses — such as “exploitations, suppressions, environmental problems, and critical situations in general” (para. 18).

Skovsmose (2016) asserts that challenging “presumptions and preoccupations” through CME must take place for a diversity of socio-cultural groups including: “students at social risk”, “comfortable students”; “blind students”; “university math students”; and “engineering students”. His recommendations for CME is useful for examining mathematics education in the diverse context of teacher classrooms in this study. Teacher awareness of cultural identities and personal histories of themselves and of their students may shape how they teach mathematics for social justice.

Educational researcher Walshaw (2013) describes how Foucault's ideas provide the language to examine how "students, teachers, and others come to think of themselves in ways that have been shaped for them and begin to act accordingly" (p. 103). For Walshaw, the project of CME is to understand the power structures that underly mathematics and mathematics education condition of being "constructed, situated within institutions, historical moments as well as social, cultural and discursive spaces" and that shape "who qualifies as knowing mathematics" (Walshaw, 2018, p. 163). While my study also examines the question of who is considered successful in school mathematics, it does not draw heavily upon CME grounded in Foucault's theory of discursive power structures. Rather, I am interested in teachers' storied experiences of relationships with students, community, and place that shape their ethical deliberation and action at this site of questioning.

Mathematics education researcher Wagner's (2014) own identified position of privilege makes him cautious about reproducing colonial patterns of power in educational relationships when working with marginalized communities and specifically Indigenous communities. However, he recognizes the greater dangers of not engaging in cross-cultural pedagogy, "which help us develop understanding of others and ourselves" and resist being "doomed to stagnate in our present worldviews and positionings" (p. 61). Wagner's concerns are related to Wall's (2006) criticism of discourse that is imposed by a dominating Western cultural pedagogy in the South Pacific Islands. Walls (2006) addresses Western power in mathematics education in the South Pacific that takes the form of dominant discourses including language and actions.

Wagner (2014) examines culturally responsive mathematics from a democratic worldview. He writes, "An important principle of democratic dialogue is that diverse views are voiced. In other words, open dialogue is necessary for democracy" (p. 63). Wagner finds it

unfortunate that most mathematics classrooms use only closed dialogue. “Teachers too frequently fail to raise the possibility of students’ autonomy” and expression (p. 63). He uses specific examples of his work with Indigenous communities and math education to illustrate open dialogue in mathematics education. He calls attention to the possible connections “among discourses in small classroom interactions, classroom cultures, academic curriculum, school systems, regional political and social networks, and very large-scale discourses including gender and race” (p. 62).

2.2.3 Rehumanizing mathematics

A third thread of CME research that is useful for my study is a theory of rehumanizing mathematics through examination of issues of identity, power, and agency (Gutiérrez, 2013, 2018). Gutiérrez’s work on rehumanizing mathematics aligns with Andersson and Barwell’s definition of CME in that it is “being driven by urgent complex questions; is interdisciplinary; is politically active and engaged; is democratic; involves critique; and is reflexive and self-aware” (p. 1). Gutiérrez’s (2013, 2018) research overlaps with the previous two sections of this review of literature in the field of CME. Along with researchers drawing on the work of Freire, she advocates for the empowerment of specific marginalized socio-cultural communities through mathematics education. As well, Gutiérrez promotes the application of Foucault’s discourse theory to analyse socio-political elements of mathematics education. I have chosen to create a separate section for rehumanizing mathematics within this review because of its primary attention to the complexities of relationships between individual students, educators, and institutions and the promotion of student and teacher agency. Her focus on individual experience and agency in her theory of rehumanizing mathematics, that aligns with narrative inquiry as a study of individuals’ experiences.

Gutiérrez's research is a significant guide for me in the process of listening to participating teachers' stories, creating field notes, and analyzing my findings. In particular, her attention to the politics of interactions within school mathematics and her theory of 'rehumanizing mathematics' provide a theoretical framework to discuss the relationships between narratives teachers share of their experiences as both students and teachers and the narratives that they are surrounded by in their work. Narratives that influence mathematics teachers' practices may be told by students, particular parent communities, schools and school administrations, district and provincial educational policies, institutes of higher education, job markets, popular culture, and media. Using narrative inquiry as a research methodology means being attuned to the narratives from the contexts in which teachers practice (Clandinin & Huber, 2010). These contextual narratives may emerge as a part of the participating teachers' storied experiences, may be part of the experiences of meeting with teachers in schools that I record in field notes, or may be embedded in my relationality to the contexts as a teacher colleague. Gutiérrez's (2013, 2018) research offers a method of identifying dominant narratives and their influences on power, agency, and identity in education. She also highlights the significance of identifying counter narratives in the work and lives of mathematics educators.

Gutiérrez (2013, 2018) recommends a sociopolitical stance for researchers and practitioners in mathematics education to address issues of inequity or, in her words, rehumanize mathematics. She describes a sociopolitical turn in mathematics education as moving beyond a socio-cultural approach. Gutiérrez details how most of the research and practice done with a socio-cultural approach draws on theories of cultural psychology, focusing on individual success, and examining school structures. In contrast, she argues, a sociopolitical approach to mathematics education practice and research aims to: highlight "identity in social interactions";

“privilege the voices of subordinated groups”; and “forefront the politics and power dynamics that arise from sites of interaction” (p. 38).

Gutiérrez (2013) is critical of initiatives to address equity issues in mathematics education by getting more students to do math and operate with a perspective of deficit for those who don't succeed when given access (p. 48). The element of equity in which students learn to ‘play the game’ does not address issues of identity and power. To do this, equity must include a possibility to “change the game” (2018, p. 2). As well, she points out that teaching mathematics for social justice does not necessarily address issues of power for students or teachers (2013, p. 49). This is similar to Peterson's (2015) point about personal engagement with social justice issues. Gutiérrez identifies two questions for educators to ask in relation to issues of power: “*Who* benefits from students learning this concept?” and “How are students' *identities* implicated in this focus?” (p. 47).

A theory of rehumanizing mathematics and mathematics education is central to Gutiérrez's (2018) work as an academic researcher and educator. She explains that she chooses the term rehumanizing “to honor the fact that humans (and other living beings) have been practicing mathematics for centuries in ways that are humane” (p. 4). One of the ways that Gutiérrez's research shows mathematics education as dehumanizing for students and teachers is the teaching of mathematics as acultural and objective, with no connection to values, politics, or ethics (p. 4). She writes,

because the production of knowledge reflects the society in which it is created, it brings with it the power relations that are part of society ... what counts as knowledge, how we come to “know” things, and who is privileged in the process are all part and parcel of the issue of power. (2013, p. 44)

Another example of dehumanizing practice is teaching mathematics or any other subject in ways that do not recognize students' identities, treating them as if they are interchangeable

(Gutiérrez, 2018). Likewise, when teachers feel interchangeable this is dehumanizing for them and discredits relational work in education. I am using narrative inquiry research methodology as a way to uphold teachers' voices and unique experiences and also focusing on the relationality in their practices as a way of rehumanizing. One aim of this study is to provide solidarity between teachers through engaging in the difficult and involved conversations of how sociopolitical conflicts in mathematics education are played out and perpetuated. Individual teachers may not have the support of colleagues or the administration when challenging practice and policies. As well, they may be caught in a dilemma of not having enough time to reflect and take action on such issues without sacrificing the immediate needs of themselves and their students. This speculation speaks to a possible recommendation of professional development for teachers that provides a venue for conversations of 'rehumanizing' mathematics.

2.3 Mathematics Education and Place

2.3.1 *What is place?*

As a Grade 7 teacher, I asked a group of 12-year-olds to write about a specific place that was somewhere not inside a building, that they felt personally connected to, and that made them feel at home. One boy wrote about his grandfather's farm in the Philippines with specific details of being on a swing by a fence. Another student wrote about her attachment and longing for particular streets of Tehran and the smell of foods cooking there. Someone else wrote of a summer cottage north of Vancouver that his family went to every year of his life. He described being in an estuary in a canoe and paddling through long grass growing in the water. One student wrote about the end of a little lane in the city, not far from our school, where she and her friends could climb down onto an old dock by the edge of the inlet. Each of these attachments to

an outdoor place involved social connection that was specific to students' own family or community, repeated visits and familiarity, and sensory memory.

Experiential education facilitates a lived mathematics that becomes part of the students and their worlds. This concept is used by Gerofsky (2018b) in her work with arts-based mathematics education. “Embodied, arts-based math learning helps students understand abstract concepts through multisensory experiences” (0:12). How teachers bring attention to personal experiences in mathematics teaching and learning can influence student engagement and acknowledge their own relationship with place.

I bring my interest in relationships with place to this project, drawing on research that speaks to mathematics education that is attentive to place. For the purpose of this study, I use the term ‘place’ to refer to a particular location with links to specific social, cultural, and political qualities and meanings. I include humans, non-humans, and the more-than-human world in this conversation.

Starting with place for mathematics education involves an acknowledgement of local cultural values and prioritizing sustainability. It means that calculated accuracy and prediction must give way to uncertainty, risk, and relationship. The abundance of places that are not captured by a Cartesian grid, clues from the land for finding our way, and the wisdom and skills of those who have lived in a place long before us are considered in a culturally responsive mathematics. As Chambers writes, “By learning to do what is appropriate in this place, and doing it together, perhaps we can find the common ground necessary to survive” (p. 125).

2.3.2 Place-based and place-conscious education

Place-based education has historically pursued the goals of connecting students to their local natural outdoor environments through hands-on and experiential learning. This has been in

part a response to an appreciation for the educational role that nature can play (Dewey, 1907; Casey, 1997) and concern for a holistic notion of student well-being (McBride, Brewer, Berkowitz & Borrie, 2013, North American Montessori Centre, 2008; Louv, 2005). Place-based education in school settings has also been developed as teaching about environmental stewardship through knowledge of local ecosystems (Lupinacci, 2013; Orr, 1992; Sobel, 2004).

Dialogue in education on globalization and decolonization has demanded a closer examination of the concept of place-based education to include social, historical, and ontological dimensions in a critical pedagogy of place (Greenwood, 2013). In this development of place-focused education, Freire's theory of critical consciousness — *conscientização* — in education, discussed in the previous section, may be applied to place (Freire & Shor, 1987).

Greenwood (2013) uses the term 'place-conscious' for a pedagogical approach that emphasizes "historical, socioecological, and ethical dimensions of place relations" (p. 97). He identifies curricular questions for focusing on a particular place: "What happened here? (historical)"; "What is happening here now and in what direction is this place headed? (sociohistorical)"; and "What should happen here? (ethical)" (p. 97). Greenwood's theory of 'place-conscious' education provides one framework for discussing teachers' experiences of relating with place through teaching and learning mathematics in this study. His questions encourage discussion of cultural difference, social justice, reconciliation, and geopolitical relations to emerge in my conversations with teacher participants. I am interested in the teacher participants' visions for living well together in place in the future and what mathematics education can contribute. Greenwood's place-conscious education applied to mathematics teaching and learning gives attention to ethics of relation that include place. This is a significant part of my inquiry.

2.3.3 *Place and ‘locating’ in mathematics education*

Cartesian maps and grids dominate Western traditions for locating place and guiding travel. Grids superimposed on abstract representations of place have been used as colonizing tools of power to claim territory and extract resources. But these grids are limited in their ability to represent knowledge of the specific details of land and how people are in relationship with place. Mohawk mathematician Doolittle (2018) writes:

Concepts that are useful on a small scale, such as plane Euclidean geometry, and its grounding in straight lines, circles, grids and other rigid figures, fail to scale to environments that are large, compared to the earth, fail to scale to the natural landscape, and completely fail to capture or even describe some of the more complicated shapes of nature. (p. 108)

Doolittle (2018) uses the example of the roads that were laid out using a Cartesian grid by the Dominion Land Survey system in Saskatchewan as a failure of grids to apply to the land. Because of the curvature of the earth, the lines/roads running south to north begin to converge. To compensate, the north-south roads stop and are reset at regular intervals with a diminishing number of roads. This creates recurring east-west jogs in the road as one drives north or south (p. 107). The Mercator projection system also attempts to represent the spherical world on a two-dimensional, planar map. Introduced in 1569 as a cylindrical map useful for navigation, this map employs parallel lines of latitude and longitude (Encyclopedia Britannica, 2021). It focuses on maintaining angles but is not accurate for distances and area, especially near the poles (Doolittle, 2018, p. 110).

Doolittle (2018) describes a different geometry, another literacy for locating — Riemannian geometry. This system acknowledges that “any grid, straight or curved, is an imposition of our own invention for our own custom or convenience,” meaning “everything that is *real* is independent of the grid system used to measure it” (p. 111). My study engages with

questions that arise from examining how abstract representations of place are explicitly or implicitly taught in public education. When did we begin to imagine that grids were enmeshed in the land, the building, or the time they were dissecting? How has school mathematics deferred to grids to define what is real? Doolittle writes,

By allowing all grids on an equal basis in a kind of democratization of frames, Riemannian geometry allows us to look past the particular grid we may be using, to refocus on the actual underlying geometry of the situation. (p. 111)

To start with the situation, not with the theory in mathematics education, is the risk required for relationship to community and place.

Rectilinear grids in school infrastructures and time schedules locate school communities in relation to time and place. These inflexible boundaries can limit activities and experiences. Gerofsky (2018a) writes of the abundance of interstitial and liminal spaces for creative work in education that is found outside and in-between the places that are mapped for certain functions or defined by product value. Generative practices in these in-between, often unseen places include growing plants and trees in unused locations around schools and roads as well as creating visual art from materials that are discarded or not seen to have value. These practices respond to the landscape and to events as they occur. They are unpredictable and open new possibilities for relating to community and place.

The Polynesian Voyaging Society, which has been in long-time partnership with the University of Hawai‘i at Manoa, has circumnavigated the earth to “spread the message of *mālama honua*, or caring for the Island Earth” (University of Hawai‘i, 2018). This active educational project takes place in a traditional-design double-hulled canoe called Hōkūle‘a, ‘star of gladness’ (Furuto, 2014, p. 114). It travels “using the stars, sun, and swell to guide us around the world” (Polynesian Voyaging Society, 2018). As they travel, the crew educates communities

about star navigation. Mathematics education researcher Furuto (2014) has taken part in several legs of their journey and espouses “the rekindling of Pacific Island tradition of non-instrumental way-finding techniques that include celestial navigation based on mathematical principles” (p. 114). The journey reaches out to students and community wherever it travels. Furuto explains that place-based and experiential learning in the Pacific communities necessarily involves the ocean and star navigation (p. 112). This conception of place expands static and continent-bound notions of place-based education, an awareness that I hope to adopt for this study.

Omushkegowuk Cree scholar Daigle (2017) describes Indigenous food sovereignty as a sense of geography that includes “Indigenous ontologies on and relationships with their non-human kin (land, water, animals and plants)” (p. 4). This way of relating with place confounds Euro-centric notions of sovereignty and land that are based on control and boundaries. Daigle writes about food sovereignty for the Anishinaabe people, that ways of harvesting and sharing food are built on “longstanding political and legal frameworks that govern the way diverse people within the nation relate to one another, with members of other clans and Indigenous nations, and with their non-human kin” (p. 5). Working in public education in the Lower Mainland of British Columbia, I have learned only a little of Squamish and Tsleil-Waututh food harvesting and sharing practices. What I have learned has been from a Tsleil-Waututh storyteller.

2.3.4 Indigenous perspectives and place in mathematics education

Examples of studies connecting mathematics and culture in the first section of this literature review offer insights into pedagogical strategies for how Indigenous perspectives and place can come together in mathematics education. I draw upon the following study to further illustrate possibilities and challenges in this endeavour. Sterenberg (2013) describes and comments on the work of a Blackfoot mathematics teacher, Byrony, at a reserve school in rural

Alberta, as Byrony works to integrate her own cultural context with the prescribed mathematics curriculum. Sterenberg describes low participation rates as one indicator for studying connections between Indigenous perspectives and elementary school mathematics (pp. 18-19).

Sterenberg describes her work with Byrony as collaborative and emphasizes a research approach that centres on attention to place and relationship. She writes: “Integral to our work was a sense of dwelling-in-place and the development of a strong relationship” (p. 25). Their collaboration is limited by the fact that Sterenberg is designing research and determining the dissemination of findings on Indigenous perspectives in mathematics education from the perspective of someone who is not of Indigenous ancestry.

By focusing on a specific local site, the Sun Dance grounds, where tipis were currently placed and where the students’ families had been camping for 300-400 years (Sterenberg, 2013, p. 26), Byrony connected mathematics to cultural practices that were embodied by students. With her students, she studied Tipi adaptations for wind and landscape through pole numbers and angles, relating specific relationship with place to Western mathematical concepts. Pan-Indigenous references, tokenism, and placing Indigeneity in the past were listed by Byrony as pitfalls for attempts to connect Indigenous worldviews and perspectives and mathematics in education. This commentary is significant for my study as I engage with the experiences of teachers responding to curriculum directives, some for the first time, to “Incorporate First Peoples worldviews and perspectives to make connections to mathematical concepts” (Province of British Columbia, 2021).

Byrony found that attempts to bring Blackfoot perspectives into lessons for ratios and scale drawings of house designs had little resonance with the Blackfoot students (Sterenberg, 2013, p. 26). Her attention to students’ lack of engagement with the material and their own lived

experiences of reserve homes prompted her to turn to relationship with place to integrate Blackfoot culture and school mathematics. She talked with an elder to learn about the historical and ceremonial significance of the nearby Majorville Medicine Wheel. “The elder spoke to her about the sacredness of this site and told her the story of how the *Iniskim* (buffalo stones) were given to the Blackfoot people and how the people were taught to call the buffalo in order to prevent starvation” (p. 28).

From her work with the elder, Byrony engaged in teaching the students about the medicine wheel and mathematics (Stereberg, 2013). She designed in-school lessons that gave the students the opportunity to examine diameter, radius, and circumference in relationship to the medicine wheel. However, this was only a small part of an educational experience for the students that included attention to cultural values, traditions, community, and being with the land. The elder talked to the students about a cleansing ceremony at the site before their visit. He led the students in a prayer and making offerings at the site to open their visiting day. Students also listened to the story of *Iniskim* (p. 28). By visiting the medicine wheel site, students were given the opportunity to respond to the land (p. 28). Attention to the sacredness of the site through listening to elders and their own experience of being there was part of their education. Connection to their own land and community resulted in the Blackfoot students becoming more engaged with the mathematics in school (p. 28-29).

This description of Byrony’s teaching practice connecting Indigenous perspectives to place and mathematics offers guiding points for conversations with teacher participants in this study. Importantly, Byrony is working with the knowledge of both her and her students’ own ancestors and in a place where their people have lived for a long time. The knowledge that she makes connections with is particular to her community and that place.

The context for my research project differs from Byrony's situation on several levels. The teachers participating in this study work with students of Indigenous and non-Indigenous ancestry in an urban environment. They will have different relationships with the local Indigenous communities based on the connections that they have built over time. However, the ethics of relationship with Indigenous perspectives and place that are described in Byrony's teaching are relevant to this study.

2.3.5 Mathematics for spatial justice

The concept of spatial justice is built on the idea that issues of social justice occur in a spatial, or place-based, context (Soja, 2010). Watson (2019) claims that theories of spatial justice recognize that "social justice cannot abstractly be reached, since social relations take place in a particular space" (p. 1). Relationships with a particular place are considered in a spatial justice approach to issues of social justice. In this conceptual bridging between relationship with place and social justice, there is an opportunity to consider how place affects the social and hence, issues of social justice. As Rubel and Nicol (2020) claim, "place acts as a shaping force in social relations, whether among humans or non-humans" (p. 175).

Teaching mathematics for spatial justice draws on theories of CME discussed earlier in this literature review, empowering students to both understand how to decode mathematical representations and to reconstruct their worlds with the tools of mathematics (Frankenstein, 1983, 2015; Gutstein, 2006). Bringing together critical mathematics and spatial justice theories means examining the ways that mathematical thinking and practices are complicit in "issues of injustice and inequities emerging and manifesting in relationship to particular places" (Fritzlan, in press-a). An example of this is a study carried out by Rubel, Hall-Wiekert, and Lim (2016) in which they develop teaching modules for high schools in New York City. One of these models

concerns students examining “the city’s two-tiered personal finance system”, specifically, the intentional dearth of banks with affordable financial services in racialized demographic areas of Brooklyn and the Bronx (p. 557).

Another example of teaching mathematics for spatial justice is to consider mathematical ways of locating and mapping place.

By understanding maps as non-neutral, arguing for a specific way of imagining space, representing specific points of view, and making visible certain entities or patterns, teachers and students can engage simultaneously with the spatial and the social justice aspects of cartography. Introducing students to alternate ways of conceiving of place can uncover status quo and unchallenged technological aspects of representations with maps. (Fritzlan, in press-a)

Mathematics education that examines and is critical of dominant ways of representing place empowers students to address issues of place. “Participatory mapping” is a method for engaging citizens “with existing decision-making entities or structures” (Rubel, et al, 2016, p. 560). An example of this that has come up in my experiences teaching elementary school students in the Lower Mainland of British Columbia is discussions of place names and who gets to decide on the names of places.

2.4 Summary of Literature Review

This literature review investigates research fields that make connections between mathematics education and socio-cultural perspectives and practices. I begin with a conversation of CRME, ethnomathematics, and cultural plurality in mathematics education as a theoretical framework for this study. Through this conversation, I have identified areas of CRME that need further research and with which this study aims to engage:

- Previous research in CRME focuses on a single marginalized cultural group and much of the research that includes Indigenous communities and CRME takes place in rural

settings. This study addresses this gap by engaging with CRME in a culturally diverse urban context.

- Bishop (2012) reports a need for educational research concerned with mathematics and cultural values. I bring awareness of this research need to my analysis of conversations with practicing mathematics teachers.
- There is also a lack of CRME research in which elementary teachers reflect on the ways in which their personal cultural practices, traditions, and values influence their teaching of mathematics. This study is designed to open conversations with participating teachers for reflection in this area through preparation of questions to prompt our conversations and an ongoing process of co-composing narratives.

Along with CRME, the theoretical framework for my study also leans on aspects of previous research in CME. I have reviewed CME literature along three lines of research development: research drawing upon Freire's emancipatory education; research drawing upon Foucault's discourse theory; and a the theory of 'rehumanizing mathematics' through attention to student and teacher agency, power, and identity. There are some overlaps between the fields of CRME and CME, for instance are both interdisciplinary — both fields are concerned with mathematical thinking and practices that span different typical education subject areas. Research in CRME and CME share a political interest in advocating for students' expression of cultural identity as a part of their mathematics education. They both promote critical consciousness. CRME differs from CME in its attention to developing relationships with local communities and place and building a mathematics education practice with local cultural knowledge and worldviews. In this aspect, my study aligns closely with CRME. CME research has developed with an agenda of placing the political in the foreground. CME prioritizes dialogue for

democracy and engagement with complex socio-political issues. Attention to agency, identity, and power of individuals and communities is a significant agenda of CME.

CME research drawing on Freire informs my conversations with teachers around their interests in teaching mathematics for social justice, especially data literacy. I also draw upon Gutiérrez's (2013, 2018) work on rehumanizing education which brings the field of CRME's attention to culturally based ways of mathematical thinking and acting into direct conversation with the field of CME's agenda of prioritizing the political in mathematics teaching and learning.

This study is an inquiry into elementary mathematics teachers' relationships with place as well as with community. Previous CRME research takes into consideration cultural practices and worldviews that bridge mathematical thinking and relationships with place. Studies in spatial justice make the connection between place and the social. A review of research literature in place-focused education brings to this study of mathematics education discussion of place-conscious education, locating beyond the rectilinear grid, spatial justice, and Indigenous perspectives of relationship with land.

CHAPTER 3: RESEARCH METHODOLOGY

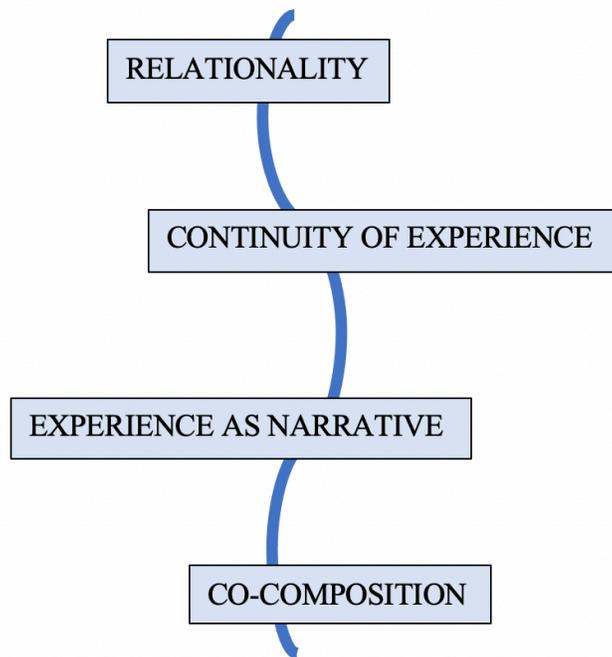
3.1 Narrative Inquiry

I use narrative inquiry as a research methodology to engage with and to analyze the relational experiences of elementary school mathematics teachers. My primary justification for choosing narrative inquiry is that it focuses on the voices of teachers; I am studying their storied experiences. As well, narrative inquiry upholds the agency in the ways that their experiences are retold and become research text. The seven participating teachers for this study are consulted as contributors, reviewers, and editors for the co-composition of their Individual Narratives. Furthermore, narrative inquiry is an appropriate methodology for this study as it requires an ethical acknowledgement of my own subjectivity as a researcher. This is particularly important in this instance as I engage in conversations with elementary school teachers who are professional colleagues of mine within the same school district.

Narrative inquiry is described as “the study of experience as story” by Connelly and Clandinin (2006, p. 477). I draw largely upon the work of Clandinin and colleagues (Clandinin, 2006, 2013; Clandinin & Connelly, 2000; Clandinin & Huber, 2010; Clandinin & Rosiek, 2007; Connelly & Clandinin, 1988, 2006) to design this research project. I look to this body of work as well as that of other narrative education researchers (Bruner, 2004; Chase, 2011; Ellis, 1995; Gouzouasis & Ryu, 2015) in order to create a ‘spine’ composed of elements of narrative inquiry research methodology. This ‘spine’ serves as a guide for my visits with participating teachers and for my subsequent analysis of data. Concepts articulating this spine of narrative inquiry include: relationality; continuity of experience; experience as narrative; and co-composition (see Figure 3.1).

Figure 3.1

Concepts Articulating a Spine of Narrative Inquiry Research Methodology



3.1.1 Relationality

Narrative inquiry approaches research “as an unfolding of lives in relation” (Clandinin, 2013, p. 141). This methodology assumes that interactions between researchers and participants matter and effect personal change. I entered into conversations with the teacher participants with the intention of discussing my research question and using pre-composed questions as prompts. However, in the moment, each conversation was guided by my relationship with a particular teacher participant. When I met Joan for the very first time, we started our conversation by trying to uncover places that our practices as teachers in the same district overlapped. She asked me so many questions that she jokingly commented that she was assuming the role of researcher and interviewing me. Some of the conversations that I had with teachers built on multiple conversations from previous experiences together as teacher colleagues. For example, Tara and I

had commuted to work together for years and so picked up on narrative threads from much earlier conversations.

As a research methodology, narrative inquiry provides a structure for the process of engaging with the living, telling, retelling, and reliving of the research subjects' experiences (Clandinin, 2013). It is a coming alongside the individuals that the inquiry focuses on; it is a listening to the storied experiences that are occurring. "Participant as knower", "reconstructing meaning versus judgement", and "openness of purpose" are principles of relational research defined by Connelly and Clandinin (1988, p. 271) that this study adopts in every phase. Additionally, narrative inquiry requires an examination of how my own stories and experiences shape the ways in which I interpret other teachers' stories. Clandinin (2013) relates that, "without an understanding of who we are in the inquiry, we are not awake to the ways we attend to the experiences of research participants" (p. 36). Exploring the relationships that I have with the district school communities as a teacher and a researcher through my own narratives helps me to hear and understand other teachers' experiences and may reveal assumptions or biases that I hold.

The concept of self-reflection in research is an acknowledgement of the researcher's own participation in the events that are the focus of study. Clandinin (2013) explains, "As we tell our stories and listen to participants tell their stories, we, as inquirers, need to pay close attention to who we are in the inquiry and to understand that we are part of the storied landscapes we are studying" (p. 24). My reflections that become a part of this study will always be in relationship to the teachers and particular school contexts. Relational reflection contains the ideas of responsibility or bearing witness to other and to self. Gouzouasis and Ryu (2015) describe this relational responsibility: "We readily embrace the position that we are neither detached nor

objective in our research position — we are wholly engaged with the self and others in our stories and storytelling” (p. 403).

3.1.2 Continuity of experience

Clandinin (2013) looks to Dewey’s (1938) understanding of experience as continuous, always unfolding and changing to ground narrative inquiry. According to Dewey, “Experiences grow out of experiences, and experiences lead to other experiences” (p. 40). Adopting this concept of continuity of experience means that the experiences of teacher participants are never considered static, complete, or essentialized. Instead, experiences are viewed as “a changing stream that is characterized by continuous interaction of human thought with our personal, social, and material environments” (Clandinin & Rosiek, 2007, p. 39).

The ethic of this conception of continuity of experience for research is that there is not an attempt to create “an exclusively faithful representation of reality independent of the knower” but to make possible new relationships between the research participants and their worlds (Clandinin & Rosiek, 2007, p. 39). It upholds a respect for teachers as experts of their own practices, as reflective practitioners, and as collaborative members of teaching and researching activities. Continuity of experience is a way to understand “both teacher knowledge and change in teacher knowledge” in a way that does not diminish the “wholeness of their lives “(Clandinin, 2013, p. 10).

The concept of continuity of experience differentiates narrative inquiry as a research methodology from other qualitative or quantitative research methodologies that may use narratives as a form to represent data (Clandinin, 2013, p. 12). For example, case studies may use narratives for data and then use a process of coding for data analysis. Coding is an objectifying process: “To codify is to manage, to arrange in an order that is meaningful to the coder” (Tuck &

Yang, 2014, p. 812). Narrative inquiry is antithetical to a process of coding as it is concerned with relational experience that is changing and continuous. It is not suited to reductive processing.

The findings of this study include a notion of time as cyclical and related to place in elementary school mathematics education. This differs from the linear sense of time that Dewey (1938) relies on for his assertion of a notion of continuity of experience. He writes, “the principle of continuity of experience means that every experience both takes up something from those who have gone before and modifies in some way the quality of those who come after” (p. 35). He promotes the ideal of objective social advances in this linear fashion.

Within this study, I open the notion of continuity of experience to a cyclical sense of time, of repeating patterns in experiences. This notion of cycles in time works within a narrative inquiry research process of living, telling, retelling, and reliving (Clandinin, 2013). The experiences that teachers share with me are retold in the writing of Individual Narratives and the identification of Resonant Narrative Threads (RNTs) but never assumed to be complete or conclusive. This inquiry intends to create possibilities for a continuity of reliving, and telling again.

3.1.3 Experience as narratively composed

Clandinin and Rosiek (2007) argue that “narratives are the form of representation that describe human experience as it unfolds through time” (p. 40). Narratives or stories told by people are ways of making sense, of understanding relationships and events (Bruner, 2004). The notion of experience as narratively composed follows Dewey’s (1976) pragmatic ontology in which ordinary lived experience is not diminished for the sake of a notion of reality that lies “beyond the reach of our writing and reflection” (Clandinin & Rosieek, 2007, p. 39). As a branch

of qualitative research methodologies, narrative inquiry provides an alternative to positivist research paradigms, as narrative inquiry values human experience as opposed to a belief in absolute world truths (p. 44).

Studying teacher experience in mathematics education research provides the opportunity to gain insights from the details of daily teaching practice that are not distilled or performed. It is an ethical approach to respecting the diversity of lived experiences and the agency of research participants. (Clandinin & Rosiek, 2007, p. 44). This is the difference between narrative inquiry and a post-positivist critical realism. “The critical realist can admit the existence of an infinite variety of private impressions, personal significances, and personal meanings. However, she reserves the term *reality* for something beyond our immediate experience that structures everyone’s experiences similarly” (p. 44). Narrative inquiry “begins with an ontology of experience. From this conception of reality as relational, temporal, and continuous, it arrives at a conception of how that reality can be known” (p. 44).

Narrative inquirers are interested in “the stories people live and tell,” which “are the result of a confluence of social influences on a person’s inner life, social influences on their environment, and their unique personal history” (Clandinin & Rosiek, 2007, p. 41). Each anecdote, event, emotion, and opinion that emerges in my conversations with teachers participating in this study is part of a narrative. Teachers’ storied experiences are also connected with strong emotions or internal struggles. For example, Tammy shares with me an experience of sadness when she was singled out in a math lesson as a child and not able to play and have fun with the other students. She tells me that this experience has made her still not like the word “mathematics”. She prefers to use the word “numeracy” with her Grade 1 students and parents.

Clandinin and Rosiek (2007) make clear that the process of narrative inquiry is not only a research methodology, but also a phenomenon. They write,

The narrative inquirer seeks a knowledge of human experience that remains within the stream of human lives. In other words, narrative inquiry does not merely describe this or that feature of someone's experience. It is simultaneously a description of, and intervention into, human experience; it acknowledges that descriptions add meaning to experience, thus changing the content and quality of the experience. (p. 44)

The fact that the inquiry process changes that which it is studying is not a concern or "methodological problem to overcome". Rather, living alongside the participants, having the study process shape the narratives that emerge and shift, is the goal of narrative inquiry (p. 45).

3.1.4 Co-composing

Experience as narrative becomes again an experience as it is retold. As stories are told and retold they affect the teller and the listener. During co-composition of Individual Narratives, stories work on both the researcher and the participants. Stories that are shared and that have a moral deliberation change us. They "have a way of almost literally getting under your skin ... making you want to live right ... making you want to replace yourself" (Basso, 1996, p. 197).

When I asked teachers how the process of being a part of this study had affected them, there were indications of the stories working on them. Telling their stories and reflecting on the Individual Narratives that were created made them want to change. For example, Claire communicated to me in an email, "Our conversations definitely sparked my mathematical curiosities ...you know how you kind of get in a rut with teaching ... It made me want to approach things in a more creative way ... like I used to." (May 25, 2020). Chelsea wrote to me that she was reflecting on the conversations that we had about her 'class economy' game and that she wanted to shift the focus away from fines and onto building respectful relationships (June 20, 2020).

It was not until I had been immersed in this project of narrative inquiry that I understood the significance of its collaborative aspect. I believe that it is this quality in particular that makes narrative inquiry “a deeply ethical project” (Clandinin, 2013, p. 30). Ellis (1995) writes of ethnographic narrative that it “permits frightening freedom — the freedom to construct and interpret along with the frightening responsibility of unearthing sufficiently the buried layers of complexity, repression, and desire in everyday life” (p. 162). The inclusion of co-composing in narrative inquiry creates a system of relational responsibility in which the researcher and the participants together work to find narrative layers and patterns through differing perspectives while maintaining agency over representation of voice. There is a playful element to co-composition as well, in which myself as researcher and participants whom I have a long-term collegial relationship with are able to prod at one another’s stories and to share tears and laughter around common experiences.

I wrote a draft of the Individual Narratives for each teacher based on the data that I had collected. I then emailed this draft to each teacher and incorporated their email or phone responses into the narratives. This process is elaborated on in the following section. Upon reflection of this study in its entirety, I notice the missed opportunity to co-compose the narratives with the teacher participants during the process of our visits (Clandinin, 2013). However, I was limited by the large number of participants (seven) and the relatively short time period for our visits (five months). The Covid-19 pandemic added further restrictions to communication with the teacher participants in the time following our three scheduled meetings.

3.2 Justifications for Using Narrative Inquiry

Providing a means for teachers' voices to be heard and their experiences included as part of the curriculum and pedagogical research landscape is an important social justification for using narrative inquiry in this study. Chase (2011) describes a pragmatic approach to narrative inquiry as having a goal to "work collaboratively with research participants to improve the quality of their everyday experiences" (p. 422). This study does not aim to provide answers for the multiplicity of contexts and challenges that teachers meet as they attempt to follow provincial curriculum directions to incorporate Indigenous worldviews and perspectives into mathematics lessons, nor does it imagine universal strategies and resources that are responsive to the needs of all communities and places where teachers work and live. However, it does attempt to make visible the processes of living, telling, retelling, and reliving (Clandinin, 2013) that storied experiences create. Within this research process there are also opportunities for teachers to find resonance and guidance for shifting their own practices.

Through narrative inquiry, I focus my attention toward the voices of teachers, my own related histories and biases, and the narratives that live with the people, communities, and places that I research alongside. I also strive to not lose sight of broader narratives of institutions, governance, industry, and media that are present in the storied experiences of the participants of this study. Through the process of rereading, relistening, retelling as a way of analysis, I enter into a cycle of reflecting and refocusing on what I am looking for.

3.3 Research Participants

I recruited seven teachers to participate in this study. Initially I had planned to recruit six, however one teacher responded to my email invitation after I had already found six. So, I

decided to include them too. I began my recruitment by contacting teachers through their school district email addresses. Initially, I reached out to four teachers who I knew from my own teaching experiences in the district. I was familiar with their practices and believed that they shared my interests in mathematics education. My email to them included a formal letter of invitation (see Appendix A). Two of the four teachers that I initially contacted accepted my invitation, and the other two responded with regrets due to other time commitments.

The next three teachers that I recruited I also knew from my previous teaching experiences. During the time of this study I have been working as an occasional teacher-on-call for the school district where this study takes place. I briefly reconnected with each of my next three recruits by chance while working as a teacher-on-call in their schools. In two of these instances, I spoke with them about my study in response to their questions when we had come into contact. Subsequently, I sent formal email invitations to participate in this study to each of them and they accepted.

The final two teacher participants that I recruited for this study were referred to me by teacher colleagues who knew of their interest in teaching mathematics. They both accepted my email invitations to participate and we scheduled our first in-person meeting.

As I reached out to teachers, inviting them to be in my study, I was also aware of trying to get a range of experiences from teaching kindergarten through Grade 7. Their teaching experience ranges from three to over 25 years. The majority of them have been teaching for at least ten years. All of the participants are of non-Indigenous ancestry. They were all born and raised in Canada with the exception of Chelsea who was born in the Philippines and attended elementary school there. I was satisfied with this group of participants as their demographics represented the teacher backgrounds of most elementary schools in this district. They were likely

to share many of the same concerns as other teachers in their district in regards to my research question.

The participants recruited for this study, using pseudonyms to protect their privacy, and the grades that they teach are:

- Claire, kindergarten
- Alison, Grade 7
- Greg, Grade 5
- Scott, Grade 6
- Tara, Grade 1
- Chelsea, Grade 4
- Joan, Grades 3 & 4

There is a diverse student population within this school district in regards to cultural identities and personal histories. As well, student populations vary between the schools where the participating teachers work at the time of this study. Some of the schools have a large Indigenous student population. As well, some of the schools have a large immigrant and refugee student population. All but one of the participating teachers has worked at more than one school in the district during their teaching career which is reflected in our conversations.

As the Ministry of Education is asking all teachers to incorporate Indigenous worldviews and perspectives into their lessons, teachers are looking to make authentic and respectful connections with local Indigenous community members. However, the opportunities for making these connections varies between schools. In schools with large Indigenous student populations, teachers in this study reach out to family members to share local Indigenous practices. Teachers also look to Indigenous Support Workers who often share local Indigenous practices including storytelling, weaving, and drumming with students and staff. Some of the teachers in this study are not able to work with Indigenous Support Workers. Within the school district where this

study takes place, Indigenous Support Workers are employed to only in schools with large Indigenous student populations. The district also employs Indigenous Success Teachers that regularly visit every school to share local Indigenous practices with all students and staff.

3.4 Data Collection: Living and Telling

After recruiting each of the teachers I found a time that we could agree upon to meet for the first of three meetings. I visited with teachers in their classroom for conversations around their experiences of teaching mathematics in elementary school grades. On two occasions, I met with teachers outside of their classrooms — with Greg for a walk and conversation along a local river trail; and with Tara at a coffee shop. Before my initial meeting with each teacher, I discussed and asked them to sign a consent form (see Appendix B).

I made audio recordings of all my conversations with teachers except for during my river walk with Greg. I wrote extensive notes reflecting upon my walking conversation with Greg shortly afterwards and consulted with him later concerning details of our visit. I also created field notes during or after my visits with all the teachers. These consisted of my interpretations of corresponding events, the environment, and my own connections to particular schools or ideas we discussed.

As well, I took photos of some of the participants' teaching materials and of their school and surrounding environments. I did not take any photographs of the teachers, students, or any identifying materials. I visited with teachers outside of scheduled class time, most often before or after school, and I did not engage with students during my visits. This process of contacting the teachers, visiting with them and gathering recordings, field notes, and photographs encompassed the living and telling phases of this narrative inquiry.

Between each visit with a teacher, I would listen to the audio recording that I had made during the previous visit and consider questions that had arisen for me. I met with each teacher participant three times over the course of five months (see Appendix D for the schedule of conversations). This practice of relistening between conversations was a way for me to reflect, begin a process of retelling, and also a way of creating a sense of continuity between conversations. The intervals between conversations varied from one week to two months depending on each teacher's schedule. It would have been difficult in many instances to remember what we had spoken about in our last meeting. I used a set of questions prepared in advance as informal prompts for my conversations with teachers (see Appendix C).

3.5 Data Analysis: Rereading and Retelling

I carried out three phases of data analysis for this narrative inquiry (see Table 3.1). Each of the phases builds on the previous one and the findings reflect a broader scope of experiences and research contexts. Specifically, whereas Phase One involves the co-composition of Individual Narratives for each participant separately, Phase Two is a rereading of all of the Individual Narratives co-composed in Phase One. The findings of Phase One become the research site of Phase Two. Similarly, Phase Three includes the findings of both Phase One and Phase Two, the Individual Narratives and the Resonant Narrative Threads, in its site of analysis. This three-phase analysis design is committed to a narrative inquiry cycle of rereading and retelling for the purpose of creating a research text (Clandinin, 2013).

Table 3.1

Three Phases of Data Analysis

	Data	Process of Analysis	Findings - Retelling
Phase 1	meeting transcripts, field notes, photographs, emails	co-composing narratives with teacher participants	Individual Narratives
Phase 2	Individual Narratives	rereading all the Individual Narratives together	Resonant Narrative Threads (RNTs)
Phase 3	Individual Narratives, RNTs, popular media, related research literature	rereading within the context of institutional and popular narratives	dominant narratives, counter narratives, relational narratives

3.5.1 Co-composing Individual Narratives with teacher participants

Once I had completed all the visits (21 in total) with the seven teacher participants, I relistened to each audio recording and transcribed our conversations. My first stage of data analysis centred around the retelling of my time alongside the teacher participants in the form of Individual Narratives for each participant. I relistened to conversations, reread transcripts and field notes, and considered photographs for one teacher participant at a time. I followed the order in which I had first visited each teacher for this process. As I re-engaged with the data for each participant, I was focused on creating an Individual Narrative that reflected the storied experiences unique to each participant and to our visits. I also considered and included my own subjective experiences in the context of each narrative.

The first step in this data analysis involved reading across all three conversations that I had with one participant and writing short forms of narratives that seemed significant in addressing my research question by placing stickies on a wall in my home office. In this way I created a picture of our conversations (see Appendix E). As well, I highlighted the places in the transcripts where these stories emerged. My second step was to use large chart paper and markers to draw the story arcs that I noticed in the transcripts and notes and to draw the connections between multiple related story arcs (see Appendix F). As a third step, I created storyline collections of parts of the three conversations as word documents by copying and pasting large swathes of the transcript texts.

After completing the three steps in data analysis described above for a single teacher, I began to structure an Individual Narrative for that teacher. I was guided by patterns of recurring and overlapping narratives, contradictory narratives, individual unique experiences and perspectives, and my own interaction within these narratives. I constantly referred back to the stickies on my wall, the chart paper diagrams that I kept on the floor of my home office, the collections of transcript text that I printed out, and additional field notes and photographs.

Making the teacher narratives into visual representations using the stickies on the wall and the chart paper story arcs was a key part of my narrative inquiry process. I borrowed from techniques of mind mapping and concept mapping (Bennett & Rolheiser, 2001) as a form of storyboarding to link narratives and make conceptual connections. These visual tools enriched the analytic process of finding meaning in the multiple forms of data (audio recordings, written transcripts, field notes, photographs, and emails). Storyboarding brings additional dimensions to data analysis in narrative research:

This visual, transitory process also becomes critical to the educational researcher's making meaning of people's lives. Storyboarding as a visual way of knowing assists researchers in

acknowledging that emotion and reason can work in creative material ways to respond to issues of voice, truth, and representation. (Naicker, Pillay & Blose, 2020, p. 134)

This study extends the narrative inquiry research methodology of Clandinin (2013) through visual retelling.

The writing of Individual Narratives was carried out over a period of time during the initial stages of the Covid-19 pandemic, March-June, 2020. Out of respect for this period of unusual work circumstances for the participant teachers, I emailed drafts of Individual Narratives to each teacher and invited them to read and comment on each one when or if they had time. I also offered the possibility of connecting by phone. In-person contact would not have been appropriate during this phase of the pandemic. All the teachers generously made time before the end of the school year to read and email me about their narratives. There were some corrections of details that I had included and a few cases where a teacher elaborated on our conversations.

I subsequently discussed with each teacher, by email and by phone due to the Covid pandemic, how their participation in this study had affected their practice or their thinking of teaching mathematics. I incorporated their reflections and responses into their Individual Narratives.

3.5.2 Identifying resonant narrative threads.

In addition to creating Individual Narratives of my visits and conversations with each participating teacher, I carried out a second phase of data analysis: identifying RNTs. I found it difficult to write this section and worried that I would be pulled into a simplifying or reductive pattern of categorizing narrative experiences. At the same time, I felt that it was important to bring the Individual Narratives together, to have them speak to one another. Bringing together Individual Narratives and noticing RNTs mimicked observing a focus group meeting, in which

individual research participants share their experiences in the context of others who may have similar experiences or perspectives.

Clandinin (2013) describes in detail a particular narrative inquiry research project in which she and several other researchers each worked with one participant. The researchers worked with the same shared research question, or in her words, “research puzzle” (p. 42). Each researcher created an Individual Narrative with their participant through a series of audio recorded interviews, field notes, and ongoing consultations with their participant. When Clandinin (2013) and her research colleagues had completed the Individual Narratives that were co-written with their participants, they met to share and discuss their narratives. Together, they looked across all the individual narrative accounts to “inquire into resonant threads or patterns that we [the researchers] could discern” (p. 132).

The design of my study, with only one researcher and multiple research subjects, necessitated a different approach than Clandinin (2013) and her research partners to finding RNTs. As I was the only researcher for this project, I was familiar with all the narratives, as I was creating them with teacher participants. However, my intention was to write them as separately as possible to maintain the uniqueness of each encounter. At one point, my doctoral supervisor had commented on how I had written one story to include so many personal details and in the next one I had hardly included any personal details. I reflected at that point on how the two teachers’ vastly different styles of talking about teaching had come through in the narratives that I created. They had both told stories of their teaching experiences, but one had woven in many more personal details. My own subjective involvement and prior relationships with the teachers, as well as the content we discussed, their assigned grade levels, the communities they

worked in and their years of experience as teachers were some of the factors that also contributed to the diversity of experiences that they shared with me.

In rereading all of the Individual Narratives together, my goal was to find narrative threads that were woven throughout several or perhaps all of the stories. It had been two months since I finished the last draft of each Individual Narrative when I first sat down to read them all together. I read through the first four in the order that I had written them and then took a short break to clear my head. I sat down again and read the final three Individual Narratives.

After rereading all seven Individual Narratives, I felt a need to find what brought the stories together. At the same time, I did not want to simplify the unique perspectives of each account of lived experiences by trying to reduce them to generalities. I asked myself: What were the sites of attraction that brought these stories together? What were the issues or tensions that the narratives came back to, or that fueled them? I went through several iterations of emergent RNTs. During the process, I also reread parts of transcripts and field notes that were related to the emerging narrative threads.

My process of identifying RNTs involved drawing out overlapping story arcs out on chart paper, bringing together large swaths of text from different Individual Narratives, and a hermeneutic process of circling back for rereading. I did not attempt to make meaning from these resonant narratives in relationship to larger theoretical frameworks. The goal of this second phase of data analysis, following Clandinin's (2013) example is to "offer broader and deeper awareness of the experiences" (p. 132) of the teacher participants. This portion of analysis is interested in patterns of narrative. In some instances, the narratives contradict one another but are concerned with common issues.

3.5.3 Rereading in the context of institutional and popular narratives

I hold onto a focus on narrative for this third phase of my narrative inquiry analysis. Narrative inquirers pay attention to the personal conditions of research participants, “the feelings, hopes, desires, aesthetic reactions, and moral dispositions” (Connelly and Clandinin, 2006, p. 408) of an individual. Narrative inquiry researchers also pay attention to their own personal conditions and don’t try to remove themselves from the research process. Additionally, as Clandinin and Huber (2010) explain, narrative researchers also include the milieu or social conditions “under which people’s lives are unfolding” (p. 436). Social conditions may be “understood, in part, in terms of cultural, social, institutional, and linguistic narratives” (p. 436). This phase of analysis is a process of expanding upon the Individual Narratives and RNTs, found in the first and second phases of analysis, to include more narratives living in the same contexts. Popular media and institutional narratives are a part of the data for this third phase of analysis. I also intentionally invite into this conversation even more narratives — those of researchers and theorists whose work can provide provocations, concepts, and language for the development of meaning within my study.

The terms *dominant narrative* and *counternarrative* serve as tools for this analysis, a way to begin negotiating relationality between the stories that teachers share with me and the stories of their living contexts. Based on threads of relational negotiations that I have noticed in my previous findings, I chose three sites for analysis: Who can do math? What counts as elementary school mathematics? and Relationships with place through mathematics education. I then inquired into dominant narratives and counter narratives in each of these sites of relational negotiation. At the same time, I resisted any path of reductive thinking, generalizing, or blending

of the particularities from the unique experiences that participating teachers have so generously offered to this study.

Within this phase of analysis, I pay attention to the stories that speak to theoretical frames of dominant and counter narratives. I also pay attention to the narratives that are not easy fits to these two opposing categories and the conversations that they invite. My retelling of Individual Narratives and RNTs in the context of institutional and popular narratives prioritizes agency to the voices of teachers and their experiences of narratives of relationship in the context of teaching mathematics. A third category of narrative emerges through this process. These ‘relational narratives’ are a significant part of my findings for this study.

3.6 Trustworthiness of Research Methodology

Narrative inquiry research methodology developed by Clandinin and colleagues as well as other researchers is grounded in relationship (Clandinin, 2006, 2013; Clandinin & Caine, 2012; Clandinin & Rosiek, 2007; Connelly & Clandinin, 1988, 2006; Gouzouasis & Ryu, 2015). The ethical consideration of the relationships between the researcher and research participants, and related communities creates trustworthiness for narrative inquiry research. Clandinin and Caine (2012) have developed particular criteria for reviewing narrative inquiry that I draw upon for this research. These criteria may be used to determine the validity of the study (Shaw, 2017, p. 212). The criteria that address ethical relationality include:

- “ethics and attitudes of openness, mutual vulnerability, reciprocity, and care” (p. 169) between researcher and participants;
- researchers entering “into research relationships in the midst” (p. 170) by being conscious and attentive to the temporality, the social relationships, and the places of participants’ lives;
- “negotiating entry” into “an ongoing relational inquiry space” that includes conversation and being a part of the research landscape (p. 171);

- ongoing negotiation of research “purpose, transitions, and texts” (p. 170) between the researcher and participants.

Employing these relational ethics meant that I attempted to be respectful and transparent in my initial contact with research participants. Using school district emails, I framed my initial contact as an invitation for participating teachers to share their practices and included a description of my research goals. During in person conversations with teacher participants in their classrooms I showed them my prepared list of question prompts and invited them to ask me questions as well as a gesture of openness and mutual vulnerability. Making field notes and listening to audio recordings of previous conversations allowed for continuity in subsequent conversations and for them to be shaped by concerns and interests of both myself and the teacher participants. I also shared educational resources for mathematics teaching with the teachers as they came up in our conversations as an ethic of reciprocity and mutual benefit. Attention to the temporality and places of teachers work environments was conveyed through flexibility and accommodation of time and place for our meetings. We often met in teachers’ classrooms, but on a few occasions found other spaces in the school that were available and also met at a once at a coffee shop close to the school and once at a river close to the participants’ home. For each of the participants we followed a different timeline for meetings that was determined by their schedule (see Appendix D). I was also aware of the participating teachers’ social contexts in the schools where they work and deferred to impromptu demands for their attention by students, parents, and other school employees.

As I negotiated the creation of research texts with participants, I was explicit about my intention for each participant’s role in co-composing and editing these texts. At the time that I began to work on a first draft of the research texts, March 2020, COVID-19 pandemic restrictions meant that the teachers were transitioning to working from home and had significant

new demands placed on them. I endeavoured to be attentive to their changing circumstances by offering drafts of the research texts through email correspondence for them to read and contribute to accompanied by a statement that I had no expectations that they would be able to find time to do this. The ongoing phone and email communications that I received from all of the participants before the end of school that year indicated their level of individual investment in our collaborative text writing process.

Narrative inquiry research undertakes the creation of a research text through a multi-stepped relational process. I followed these steps for creating a research text and they provide criteria for judging the validity and rigour of narrative inquiry research (Clandinin & Caine, 2012; Shaw, 2017). They include:

- beginning the research process with narratively “inquiring into researchers’ own stories of experience” (Clandinin & Caine, 2012, p. 171);
- “moving from field to field text” (p. 172);
- “moving from field texts to interim texts and final research texts” (p. 172).
- “committing to understanding lives in motion” that our stories of experience are not static and never complete (p. 175).

My own narratives expressed as autobiographical writing in the first stages of this study are a significant part of my justification for my research goals; they are also part of the data for this study (see sections 2.3.1 & 6.3.2). The ‘field’ in these step-wise criteria for trustworthiness indicates an established safe space for inquiry — for example, setting up meetings with teachers in their classrooms — and ‘field texts’ refers to photographs, audio recordings, and written notes related to conversations. The ‘interim texts’ include the drafts of narratives and associated notes communicated back and forth between the researchers and myself by email after our series of conversations. The ‘final research text’ refers to this dissertation. Together, these writings form a snapshot of the lived always changing experiences of myself as researcher, the participants, and the time, place, and communities involved.

One more criteria for reviewing quality and genuineness of narrative inquiry research projects (Clandinin, 2013; Clandinin & Caine, 2012) is important for this study. It is:

- developing a research text with “relational response community” (Clandinin & Caine, 2012, p. 173).

Feedback for my dissertation writing has come primarily from my doctoral supervisory committee. Dr. Michael Marker, an Arapaho scholar in the department of Educational Studies at The University of British Columbia, as part of my supervisory committee until he sadly passed away in January of 2021. In my initial meeting with Dr. Michael Marker we discussed meanings of land and place in connection to mathematics. We held a mutual interest in mathematical chaos theory. This introductory conversation that I had with Dr. Marker shaped my ongoing exploration of generative and non-linear understandings of relationship with place and is reflected in my analysis of the role of place in elementary mathematics teachers’ experiences (see section 6.2

I valued Dr. Marker’s perspectives as a person with Indigenous ancestry on my research. This was particularly important as I was in conversation with teachers about incorporating Indigenous perspectives into their teaching practices and all of the teacher participants and myself are of non-Indigenous ancestry. During the oral defense of my comprehensive examinations, Dr. Marker spoke of paying close attention to the use of the concept of cross-cultural exchange education, a recommendation that I have attempted to carry with me during my studies.

On another occasion, I had an extended impromptu conversation with Dr. Marker about his long-time relationship with the Lummi Nation as an educator at the Lummi high school and Northwest Indian College and as a university researcher. Reflecting on this conversation makes me appreciate my own long-term relationships with the communities and place for this research

and also gives me a perspective on my research endeavours and relationships as very brief on the scale of the histories of this place.

Dr. Marker read and commented only on parts of what eventually became my complete dissertation. Diversity of individuals who give feedback for the creation of a research text can enrich the process and this can include “interdisciplinary, intergenerational, cross-cultural, academic, and non-academic members” (Clandinin & Caine, 2012, p.173). Future narrative research that I undertake would benefit from extending and formalizing my “relational response community” to include a more diverse group of individuals.

CHAPTER 4: INDIVIDUAL NARRATIVES

This chapter and the following two chapters present the findings for this study. The research question that these findings address is:

In what ways do teachers' experiences of relationships with community and place shape their strategies for teaching mathematics in an urban and culturally diverse context?

The focus for this chapter is the findings of the first phase of analysis for this study.

These findings consist of seven Individual Narratives, one for each of the teachers participating in this study. Each narrative is a retelling of the in-person meetings that I had with the participating teachers. The events of our meetings are written in the present tense, as an unfolding of shared ideas and the emergence of our stories. I added layers to the retelling of these narratives as I listened to the audio recordings of our conversations and re-examined transcripts, field notes, and photographs. The participating teachers contributed to the retelling of our meetings as they responded to my invitations to read and edit the narratives I proposed.

The teacher participants have been given pseudonyms to protect their privacy. Specific place names and all other identifying details have been changed or left out. Reference to students' parents and families within these narratives includes guardians and other parental figures.

4.1 Claire: Patterns of Counting, Reading, Drumming, and Breathing in the Everyday Life of Kindergarten

Claire and I cross paths unexpectedly in the fall of 2019 in an elementary school staffroom. I was once a full-time classroom teacher at this school but am there as an on-call

teacher on that particular day. Claire is still teaching Kindergarten and I admire her enthusiasm and energy after nine years at this special needs designated school.

Over lunch, surrounded by colleagues at a lunchroom table, Claire and I catch up, fill each other in on the details of our work and families since we last talked. Claire asks about my doctoral research and her genuine interest prompts me to spontaneously ask if she would consider being a participant in my study. We chat again after school so that I can give her more information about my study and she is still interested in participating. As I'm leaving and Claire is standing in the atrium just outside her classroom, she blurts, "But really, I'm teaching math all the time and I often don't even realize it." Looking up high on the walls of that atrium in that moment, I can see the mural that my class of Grade 7 students had made nine years before. I wrote about the creation of this mural as a part of my master's degree capstone project. Reconnecting with this school community gives me a sense of continuity in my research process.

A month later, in our first scheduled interview, I ask Claire to tell me about her experiences as a mathematics student in elementary school. She recalls that "it came fairly easy to me". However, in high school, she explains, "it really depended on my teacher and on how it was being taught to me". She applied this idea of students' learning in mathematics depending on how it was taught when she worked briefly as an elementary mathematics specialist for struggling students: "I would see how many different ways I could teach them, and how many ways they could think about how to learn it ... I did a lot of research on different ways I could go about helping these kids to understand it better".

Examples of mathematics lessons that Claire shared with me over the course of our three visits illustrate her belief in using multiple approaches and an intentional blurring of disciplines.

An example of this is how she describes teaching patterning as extending through mathematics, literacy, and science.

Claire: It not only helps them [the students] understand patterning in math, but then also when they are learning how to read. It helps them guess what the next word is going to be and it helps them understand the patterns of language... I focus on the patterning in stories and poems... and also with the seasons and the life cycles, we talk about how patterns happen.

During our second meeting, I ask Claire about her connection to this particular school community and place, and she explains how her connection comes from being “here for a while”, “getting to know the families”, and “opportunities to go outside ... down to the beach ... into the forest.” She gives examples of numerous ways that she is part of connecting mathematics with local Indigenous perspectives through local Indigenous cultural practices. There is a municipal park down the hill and across the road where she takes her students.

Claire: So we used to do... [nearby park name] Wednesdays. And so we would walk down every Wednesday with the K classes. We would have some free exploration time. Sometimes we would bring some curriculum stuff to do. We would go and make patterns on the beach or pictures on the beach. And then we would also have our First Nations support workers come down and do songs and oral history ... We also had a student from the Tsleil-Waututh Nation who was learning the language, so she would come and teach us counting in Hul’qumi’num ...The kids this year are really getting it and are really, really embracing it a lot. And I heard some kids counting the other day while saying that they don’t think they were actually counting, but they were remembering the words.

Figure 4.1

A Park close to Claire's School that the Kindergarten Students Visit on Wednesdays



I inquire further into Claire's connection with the place where she teaches, specifically asking about her experiences with the kids and locating as a mathematical concept. "You'll ask them 'Where are we?' and get five different answers, 'Canada,' 'In Vancouver,' 'We're in school,'" she replies, imitating the students. She adds, "It's a really hard concept for them at this age, to have to look too far beyond themselves." She continues by bringing up the notion of a "sense of place."

Claire: With the Indigenous focus on a lot of stuff we talk about sense of place, a lot more than we used to. It has to do with the First Peoples Principles of Learning, we all

exist and coexist in this place, and trying to find out what is important and what is in this area.

When I ask her about specific intention to indigenize mathematics curriculum, Claire offers her own experiential knowledge.

Claire: I think the main thing that I've heard over the years from our Indigenous support workers is that it's better to try and kind of fail at it than not try at all ... It's a very slow process of finding out all these different things and ways of knowing and, you know, just trying to connect things as well... It's a hard one. A big question for even teachers that have been teaching for a long time is, How do I make this authentic? Which is why it would be great to have somebody come in and show us what else we can be doing... It's hard if you're thinking of math as just one thing, "Oh, it's counting the numbers and adding and subtracting and dividing"... If you're only thinking of math in those terms, it's hard to think outside of that. So it's looking at the bigger picture of the mathematical thinking too.

Reflecting, I can see how Claire's approach to mathematics education — to do it as a part of daily classroom routines, as embedded in culturally based activities, as well as interconnected with all subjects — was a way of attending to the needs of each individual child. Through our conversations, it becomes evident that Claire is attuned to the wide socioeconomic spread of the community and to the students who do not have the chance to practice numeracy at home prior to or during their kindergarten year with her. She speaks of children who live with trauma. She speaks of children who are not ready to learn.

Our third interview is different. It's been a few months since our last conversation and we have already covered a lot of my prepared questions. Between our meetings, I listen to the audio recordings and find that I have a few new questions.

Amanda: Last time we were talking about math being pushed aside ... as a school-wide focus. We were talking about how literacy is a big one that schools try to target. And now, in a lot of schools, including here, it's social emotional learning. And, I'm wondering if you can think of or imagine, if there are ways that teachers can address social emotional learning through mathematics?

Claire: Well, I could see certain ways that you could incorporate them together. I don't know how you would use math to teach social emotional. I should have looked at your questions before!

Amanda: These are fresh questions.

Claire: These are fresh questions? [laughing] Because we went too fast.

Amanda: We're in the extension now. [laughing] You've already got an A plus.

I appreciate this back-and-forth banter made possible by Claire and my shared history, our understanding of the same complex issues wrapped up in the stories of teaching in this place at this time. I also appreciate Claire's willingness to play along with my speculative questioning. I am asking her to imagine something new, a new way to think of mathematics that stays with the tensions and challenges of community histories and interpersonal relationships. This line of conversation follows Maxine Greene's (1995) description of imagination as a necessity for seeing one's way out, or as an alternative to, a difficult situation. Our conversation continues.

Claire: Okay. I'm coming from a kindergarten perspective, so everything is those very basic little things like teaching kids how to breathe and counting ... That's kind of where I go with that, the calming techniques ... Connection to your, their body ... It's funny that I automatically go to counting though.

Amanda: Well yeah. You can count your breath.

Claire: We often do the gauge of how you're feeling, different levels of things ... Have you asked this to other people? ... Do you have an idea?

Amanda: Well, I have an idea about collecting things, and why do you collect that? Different people like different things. And learning respect of difference.

Claire: Well, and sorting things ... and compartmentalizing, it can be a kind of attuned, mindful, relaxing meditation.

Amanda: Like when I do weaving with the older grades.

Claire: Weaving is patterning and ... knitting.

Amanda: So practices that are mathematical that are relaxing.

Claire: I'm thinking of those mandalas. Those are very mathematical. The colouring of those are repeating patterns ... what people do to calm their bodies. And that's meditative like over and over and over again kind of the patterns and things right ... That can be very, very calming ... And it's a lot about the patterning right around your patterns. Weaving is patterning, crocheting all of that stuff. Drumming is patterning.

Each teacher at this school has been taught how to make their own drum. Tsleil-Waututh support workers practice traditional drumming here with students and teachers. It is a community

event. As a practice of patterning, drumming may also be considered a mathematical event (Bishop 1988; Devlin, 1994). The patterns in drumming are embodied by the participants. These patterns are available to be noticed and considered as metanarratives. They may be found or recreated in other ways such as writing with number or letter symbols, counting out loud, arranging objects, and noticing changes of seasons. I think back to an earlier comment of Claire's when I asked her about showing students the usefulness of mathematics: "Actually it's just the basis for everything!", a repeating pattern in our conversations.

4.2 Alison: Transdisciplinary Inquiry Within a Culturally Diverse Community of Learners

As I enter the school where Alison teaches, the three o'clock bell rings and students stream past me, heading out to the sunny October afternoon. I find Alison in her Grade 7 classroom where a few students are still gathering jackets and backpacks. We sit down at a table and she points out the tall oak book shelf that I gave to her when I moved out of my Grade 7 classroom across the hallway four years earlier to begin my doctoral program. In the intervening period, Alison informs me, she has completed a Master's of Education degree on the topic of "creating a love of reading in the classroom". She reads a picture book to her Grade 7 students every morning and makes connections to other parts of her teaching. She explains, "I can incorporate things based on the math that we're doing, or something that's happening." As I listen, I think to myself of a goal of creating a love of mathematics in the classroom.

When I ask Alison about changes in education since she was a student, she responds by articulating her understanding of her role as a teacher.

Alison: The teacher was the person that just gave the knowledge, whereas now, I feel like I'm trying to get the students to create their knowledge

themselves. So I'm more of a facilitator and more of that guide on the side that helps them get to those answers themselves ... I feel that when students construct knowledge on their own, they're making those connections more deeply.

A facilitator role makes sense for teaching with the inquiry-based International Baccalaureate program that this school has adopted.

Alison describes for me an example of a transdisciplinary inquiry which her class is working on. Students are designing a food truck as part of a larger unit on the relationship between cultural values and consumption choices. Working in groups, she explains that "they then have to come up with a theme for their food truck based on a personal cultural value. We have one that's a fusion between First Nations and Mexican food." She goes on to describe the mathematical components of this project.

Alison: We're looking at financial literacy. We're starting with percent in terms of discounts, tax, things like that. And then we're looking into them creating their break-even for one menu item on their food truck menu ... The students figure out how much do the ingredients cost to make for how many servings and then they think about, "Okay, what are some of the costs associated with running a food truck?"

To facilitate student research for the food truck project, Alison organized a field trip to the multiple food trucks that park daily beside the Art Gallery in downtown Vancouver. Not only did students sample the foods, "they looked at the design outside, how it's laid out inside, as much as they could. But we were able to get to six or seven food trucks." By designing the

layout of the food truck and building a scaled-down model, students learn the concepts of space and shape.

At our next meeting, several weeks later, I hear from Alison about another field trip that she is planning to a park within walking distance where her students will take part in planting native species. This is intended as a community experience component of a larger climate change study. Alison's appreciation of connecting students with experiences and places outside of the classroom is evident.

Alison: I love that we can walk to the public transportation and be downtown with the students. We can take a bus to go on a field trip, like a public bus ...
And I love that we can walk too, not very far, and be in green spaces.

When I ask about other ways she might teach mathematics as applicable or useful in the 'real world', beyond the school walls, Alison's answer makes me think again about my own assumptions about what is real in education and how this might relate to mathematics.

Alison: I hate saying 'real world' examples, because the school's still the 'real world' — but in applications that will be helpful to them in their 'real life' ... So, for percent, that's really applicable to taxes and to discounts. We can physically see that, and we try and do problem solving word problems so that it situates them in a specific scenario.

For Alison, the 'real world' includes 'real life' inside and outside of the school.

The notion of 'real life' in our conversations is further complicated by Alison's description of another inquiry project that she facilitates. In this particular transdisciplinary project, students play a simulation type game in groups with the aim of creating a civilization over a six-week stretch of class time. Making connections to mathematics, they study ancient

Babylonian, Mayan, and Roman numbers and base systems and then invent their own numeracy system. Each group of students, or civilization, also has to keep track of their population size and plan for military action and trade. In this simulation, populations grow with the passage of time, one school week = 600 years, but can also be devastated by plague, volcano, or drought which are introduced by chance. On one such occasion, Alison recounts to me, “one of the students started crying she was so upset” by the sudden and unpredictable loss of lives.

This blurring between the real and not real that happens in schools reminds me of a conversation that I had with another teacher participating in this study — Chelsea — in which students had difficulty discerning between real and not real money in an extended classroom economy game. As a teacher myself, I have been constantly reminded of the very real role that imagination plays in the lives of my students. As well, students discover their worlds to some degree at schools. When I was teaching at this school where Alison is now, I often thought about the impact that my teaching had on students who were new to Canada, who were looking to me and other students to help them adjust, to fit in. Alison has commented, “This is such a transient population and we get so many new immigrants that every year there’s brand new people.” I wonder as I write this, What histories and values did I highlight for students who were experiencing immense geographical and cultural shifting? What did I hide, or not see? How did this affect the mathematics we practiced?

Inquiry projects where each student can bring their own cultural practices and histories to their work is one strategy for responding to cultural diversity in the classroom that Alison’s lesson examples illustrate. This approach is also a strategy for another more pragmatic consideration in teaching mathematics that comes up in my conversations with Alison: accessibility.

Alison: I feel this school in particular has such a range of ability in math because they come from so many different places ... we're so multicultural ... All are coming with such different background knowledge about what we're teaching.

She describes using mathematics teaching methods of 'visible thinking', and 'low floor-high ceiling' type questions, and project work "so that everyone can start in at a certain spot but then there is room for those people that want to extend". As an example of an accessible project, she shows me student work for learning about area and volume in geometry through a project of making bentwood boxes with the Haida story of "Raven Brings the Light" and describes extensions.

As a teacher at this particular school, I once created a project in which each student made an exhibit about a language and we invited other classes to come and interact. This was my attempt to respond to and acknowledge the multitude of first languages spoken by the students in my class, approximately fifteen different languages. I think that it was a positive experience for many students, including those in other classes who came to interact. However, I worry that for some, it may have been an exercise in tokenism. I always gave a timeline and assessment criteria for inquiry projects. Culturally appropriate methods of studying and sharing particular cultural knowledge practices may not have been respected within the parameters that I established.

In our third meeting, now the middle of November, I ask Alison, "What is your experience of staff and students' responses to the recently revised curriculum for integrating Indigenous perspectives at this school in particular?" Alison replies, "I feel because we have so many First Nations students in the school, that it kind of just comes as second nature. And also having the First Nations support workers in the school, they're such a really good resource."

First Nations support workers share cultural knowledge and practices within classes. Weaving, mentored by a Squamish Nation support worker, is available for all students as part of the afterschool programming here. Alison points out the mathematics of patterning in this weaving.

Reflecting back to our first conversation in early October, I begin to understand how Alison's approach to teaching as a facilitator — for students to create knowledge through connections — shapes her own learning and professional development. Additionally, her ongoing inquiry is always in relation to the students and the culturally diverse community with whom she works. The conversations Alison and I have been having are a 'real' part of our own ongoing inquiries.

In our third meeting Alison shares with me a reflection of her personal experiences in mathematics learning and how it affects her teaching: "I was lucky it came naturally. But as a teacher I find that because of that sometimes I don't know the struggles that other students have and how to help them." I tell her how this makes me think about my own tendency to want to leap ahead and make multiple connections teaching mathematics, perhaps not connecting with some students' learning styles and perspectives. She brings out a teaching resource, *Building a smokehouse: The geometry of prisms* (Kagle et al., 2007), that her current Grade 7 teaching collaborator has recently purchased. I tell her what I have learned of the long-term research by Yup'ik community members and educators with the University of Alaska that is behind this resource. I feel pulled by the memory of being a regular collaborator and inquiry project designer/facilitator with Alison and others at this school and glad to have a chance to share our teaching stories again.

4.3 Greg: Relationship to Place over Time and the Language of Numbers

A student feels the wiggle of a tiny salmon fry against their fingers as the water cupped in their hands begins to leak out. Lowering their hands into the cold Squamish River, they hesitate before opening, releasing, and the fry is gone (Field notes, November 10, 2019). This experience affects students, insists Greg. He emphatically relates to me that in his ten years of teaching as an environmental education specialist for the district at an outdoor school that runs residential programs for Grades 3 and 6, he has found that it is the authentic experience of connecting with the environment, the natural world, that is the most valuable part of this education.

As we talk, Greg and I are walking alongside the Mamquam River looking for chum salmon who habitually spawn at this time, mid-November. We come across bear scat on the path and I learn from Greg that the bears have come down from the nearby mountains to feed on the spawning fish and for the warmer temperatures in the winter. Desperate for fat for hibernation, Greg tells me, the bears eat the brains and stomachs of the salmon. In the spring, the bears will go back up the mountains in search of new shoots and berries. Along with the bears, the bald eagles that we see in the trees over a widening in the river depend on the salmon and will die without them. The many weeks of unusually low rainfall this fall has meant that the rivers aren't swelling and that the chum are slow to arrive this year. Fishing in this river has been temporarily prohibited as a consequence.

Figure 4.2

Walking along the Mamquam River



When I asked Greg to be a part of this study, he was excited to talk about place-based education but not sure what he had to offer for mathematics: “Mathematics? Being an elementary school teacher who teaches all subjects, I am probably like a good majority of elementary school teachers in that mathematics is probably not my strongest subject that I teach.” Mathematics was taught to him in a mechanical way in high school, he elaborates, and he would ask his teachers what the meaning was associated with the mathematics that they were learning.

As well as working at the outdoor school in the past, Greg has been employed for thirteen years as a classroom teacher. For our three in-person conversations, I met him once to walk and

talk alongside the Mamquam River and twice at the school where he is currently teaching. Sitting across from me at a long wooden table in a small resource room at his school, Greg responds to my questions about connections between community and mathematics with the example of an integrated unit that draws from the Grade 5 provincial curriculum.

Greg: The Grade 5 curriculum looks at immigration and past discriminatory policies of the federal government and provincial governments. So that includes native residential schools and the reserve system. That includes *Komagata Maru* and Chinese head tax and Japanese internment ... And so you're teaching about immigrants and immigration from Europe and other countries displacing the Indigenous peoples, forced off their lands, often not treated fairly.

Greg describes the demographics of his students. "I had a class of 28 students. I had four children that had both parents born in Canada. Half my class were born in Canada and half were born outside of Canada." He explains how he worked with his students to make a data set for themselves through asking one another questions about immigration. Greg explains that the ten- and eleven-year-old students came up with questions such as "Where were you born? And where were your parents born? What languages do you speak? What languages do your parents speak?". Greg continues to recount how this data set was used by the class to learn concepts of statistics presentation and analysis.

Greg: So then we had all this data. They used that data when it came time to do graphing ... we could do pie charts, we could do frequency charts, we could do pictographs. And so we used their, our data. And we compared the boys to [the] girls. We compared moms and dads to the children in the class. And at the same time, we're looking at immigration and contributions of immigrants ... It was our data, it was

not data from a book. And I think in terms of my teaching of math here in five years ... I think that was the math concept which I probably did the best job, because it was the one that was most authentic, most real. It was integrated with what we were doing. It was our own data set ... When we did that, it didn't feel like math ... they're just curious ... it's making it real.

My original conversation with Greg does not include a critical examination of what the students looked to in order to create their questions or how the questions themselves can be limiting or oppressive for individuals. This would be an interesting and valuable question to discuss further with teachers and to bring to the students. For example, asking for simplified answers about language(s) spoken through a survey format could be perceived as invasive for some children or parents. Learning about the role of language in people's lives such as for different social, cultural, and political situations as well as the ways in which different languages are experienced by one individual at different ages and in relation to formal schooling could broaden this study with the students. As well, students who knew multiple languages would have the opportunity to think about their own choices for which languages they spoke in which contexts, giving them a sense of agency.

Greg explains to me how teaching about residential schools for Indigenous children and forcing Indigenous peoples off of their land has more meaning when taught in a larger context that resonates with students in some way, rather than as isolated lessons with references to unknown places. He describes an event of taking his students on a walk to a former residential school site, a prominent building that is still standing and that is only a few blocks away.

Greg incorporated mathematics into his lessons of history of social policies in Canada with students through a reflective study of data, creating and studying themselves as immigrants. He

also talks about the challenges of teaching about colonization and immigration at the same time: “it really shattered or challenged their perception of Canada because they came to Canada as immigrants feeling welcomed here ... recent immigrant families not realizing that Canada has this dark past.” Greg is opening up conversations for his Grade 5 students of how immigrants have not been welcomed to Canada at all times, and the histories and power of Canadian government immigration policy.

We are reaching the end of this branch of the river, or rather the beginning, furthest from the ocean. There they are, two male chum following one female. They are waiting for her to release her more than 2000 eggs, at which point they will release their milt for fertilization. The adult chum will die a few days afterwards. Their bodies provide food for insects that in turn become nourishment for the young salmon fry that hatch in the spring (Field notes, November 10, 2019).

Greg and I turn around and continue our conversation as we walk back along the river trail. Greg sketches out for me the details of running an educational fish hatchery, including measurements for river conditions, statistics for species populations, and ratios of milt and roe for fertilization. A few weeks later, back at the school, he reflects on these mathematical calculations.

Greg: The different species have different incubation periods so they all hatch in the spring. So that is all mathematics within nature. But I’ve never pointed it out as mathematics. I never explained it as mathematics. I think in my teaching when it comes to mathematics, you get so locked into [thinking that] mathematics is about numbers and calculating and the more abstract side of mathematics. So, it was there

in the content and some of the teaching, but never acknowledged. But it's there. But the kids would never know because I never pointed it out.

I've just turned off the audio recorder, our third and final interview finished. As I stand up to make my way out of the school, we agree to meet again for a walk in the spring. Greg comments that he is on his way to a meeting about the restoration of the shoreline where the Squamish River meets the ocean. Kiteboarders like to access that area via a built dock-like structure that limits water flow and closes off a large percentage of the estuary, he continues. There is a plan to build docks and bridges to keep open access for people and spawning channels for fish. Chum salmon, the offspring of the salmon we saw on our river walk, spend their first summer in this estuary.

Greg's story reminds me of the humpback whales that I saw off Pender Island the week before, which, Greg informs me as I tell him my story, were on their way to Maui. His eyes light up as he tells me of a humpback whale that he encountered in Desolation Sound the previous summer. It went right under his sailboat, he claims. According to Greg, an acquaintance of his who has been sailing these waters since she was a child is noticing the return of the whales. He tells me that the whales are coming back to the Georgia Strait, the Salish Sea. Lingering a little longer, I ask Greg about the relatively recent increase in herring populations that I have heard of. We compare notes about the creosote painted on pilings as a wood preservative that was killing herring roe. Off the top of his head, Greg gives me data sets of numbers of pilings replaced and of herring populations returning. I notice that a language of numbers punctuates our stories, supplying evidence, and shaping how we speak to one another of place and of change.

4.4 Tara: Co-Creating Learning with Students

The conversations that Tara and I have for the purpose of this study are not our first. At one time, we were both classroom teachers at the same school and we would drive together to and from work. On our half-hour commute, I remember, Tara and I would recount events from our weekends, plan her kindergarten and my Grade 7 joint buddy classes, and then listen to one another's daily anecdotes as we headed home.

Today, I am asking Tara to reflect not only on her current Grade 1 teaching experiences, but on her 17 years of teaching at different schools within this district, working in communities with different histories, demographics, and geographies. Tara also has experience as an ELL teacher, a Grade 5-6 teacher, and a district pro D administrator.

As we begin our audio recorded conversation in her classroom, me with my list of prepared questions, Tara openly shares her memories of learning mathematics.

Tara: This is not a very fond memory, but I have memories of standing at the blackboard and having to do my times tables and not being able to go do the fun stuff until I had done a certain number of equations at the blackboard. With my whole class behind me doing, you know what, they were having fun and doing what I wanted to do. But I was still standing there trying to figure out my equations ...

At university, she tells me, she had to repeat a statistics course required for her B.A. "That gigantic lecture hall with the hundreds of people ... the academic lecture just did not work for me at all." Luckily, Tara recounts, she found a smaller evening class taught by an interim lecturer who related the coursework to his daytime profession. She explains, "He had a very different way of teaching ... it was relatable and more hands on ... and I probably felt more comfortable going to him and asking him questions and getting help."

As we talk, Tara makes connections between her own experiences as a student and how she approaches mathematics teaching.

Tara: I really struggled as a student and I was the student that always needed more support. And so I come at my teaching, I think, with that sort of background and so I can relate to my students who are struggling. I hope I teach differently. But I think when I'm stressed, I revert back to the way that I was taught more sort of prescriptive standing at the front of the classroom. You know, like telling the students what they are to do ... But I don't really care for the way I was taught. So I try to teach differently.

She also shares her philosophy of teaching and learning with me: "My belief is that we're all learning together and that the students have just as much to share with me as I do with them and that we are co-creating our learning together. That's my hope." I hear this and ask if it is connected to her graduate work in play-based learning that I knew about from our previous time working together. She tells me, "I think anything can become play, and you just have to have hands on materials." She recalls a time at a previous school where she felt "more freedom to let the kids play and explore" because of different parental expectations and grade levels.

Tara: We would go out into the forest and we would gather materials and count things. The curriculum was different for kindergarten ... you only have to focus on one to ten. You can do really amazing stuff with one to ten ... We'd gather materials, count things. They would make big pictures in the forest too, and do patterning with different leaves and sticks and rocks.

At her current school, which Tara tells me has a reputation for being ranked high by the Fraser Institute for the annual provincial Foundational Skills Assessment in the area of numeracy, she

says that she feels a “stress of having to show the parents what the learning looks like” and that this keeps her from taking the students’ learning outside.

Tara: Maybe we [teachers] feel like we need to be more academic. And if we’re more academic, that means we have to be in our four walls ... But as I’m saying it to you, it really does not make any sense ... There are trails and there’s this whole forest back there where they love to go and they just play back there for hours. And then we have, off to the side, some benches and so you can sit and do some teaching there ... there’s really no excuse to not be out there all the time.

In the same conversation, I learn how Tara has managed to take mathematics out of the classroom with her students through a recess survey activity.

Tara: In October, we did a survey of the school ... So we had two different pumpkins and they [the Grade 1 students] set up a little station out in the playground. And they used the white board, and they took a survey, and they had to put tallies up of “Which pumpkin do you like better?” They were decorated differently ... “Come and vote for your favourite pumpkin.”

Amanda: I love it.

Tara: The only problem was we had to do it twice, because the first day I came into the classroom and you know, they’re just so helpful ... They totally erased it ... I was just like, “Oh, goodness, all your hard work.”

Amanda: You guys did it again?

Tara: We had to do it again.

I appreciate that this mathematical exploration is embedded within a narrative of the specific event with her students. For Tara and her students, the process of these lessons is as important as the product.

For our second meeting, Tara and I choose to meet in a coffee shop. Here, Tara expresses her feelings of difficulty in showing student work to the parents.

Tara: I feel this stress from the parents too. Because, if there's the worksheet then they know that we've done something, whereas I know we've done something, but I feel like it doesn't look like we've done anything. If I don't have the proof, the piece of paper ...

She goes on to paint a picture of the ways in which she designs her mathematics teaching to alleviate performance stress that she feels students may encounter.

Tara: It really makes me focus on just like the basics ... we need to just work more with manipulatives and getting them to make me number stories with just with manipulatives before moving to the equations ... And them to talk more about their thinking ... Having the language.

Amanda: Do you think they have a sense that there's more than one way to do something? And, that their own thinking is important?

Tara: No, not yet. Even at 6 years old, I think they even already know — a lot of them really like math — but I think they already even know, “Oh, math is something that I'm not good at.”

Amanda: Where do you think they get that from?

Tara: I don't know where they get that from. I don't know.

Amanda: But it's either you're good or not good. That's really interesting, thinking of just backing up and going back to the concrete, to the manipulatives, to the practice, and taking care of anxiety, preventing it.

Tara: Exactly. And for myself as well. And not worrying about the paper and the work that's being done in the Duo-Tang.

Back in her Grade 1 classroom for our third meeting, I ask Tara if she has experiences of Indigenous perspectives being incorporated into teaching at this school and she replies, "Not so much. But we were doing it all the time at [a previous school] ... That's how we reached the kids" (Field notes, February 20, 2020). Tara and I worked with many students who were members of the Tsleil-Waututh Nation at that school.

Amanda: Can you give me an example?

Tara: Teaching them the letter sounds, if I had a picture of something that wouldn't really resonate with them ... But if I had a canoe or a picture of a canoe ... that was more tangible for them, they got more connection to it ... I think it was just trial and error. I just figured it out after years of doing it.

We talk about some of the difficulties connecting with parents and guardians of that school community where we had worked together. She references holding student-teacher interviews that took place in the gymnasium on the Tsleil-Waututh reserve.

Amanda: How would you explain or articulate the fact that the parents didn't connect with the school and why?

Tara: I think it's because of residential schools ... don't they say it's going to take seven generations for the healing? ... Also, I think in our situation where we were at the gym, sitting at a table, you know. I think the format maybe needed to

have been different ... maybe something social where we were just there, we had a meal together. And we could just casually talk about their child. What we love about their child and their positive strengths ... I don't know, that's just my thinking.

Amanda: And when you were working there, did people have conversations about residential schools or did you get that from many parents?

Tara: No ... I didn't really know about residential schools. And we never talked about it.

I shift our conversation back to teaching mathematics.

Amanda: Do you see a place in mathematics education for connection with Indigenous culture?

Tara: Yes, absolutely! Yes! In terms of the weaving done traditionally and the basket making and the beading, all of that. Pattern, colour, lines, and math, it's all math ... And getting a canoe to go down a river.

Tara brings up a workshop that she recently attended on Indigenizing curriculum and how it made her think of her own teaching practice. She identifies in relation to both the workshop and her teaching practice “this tension between wanting to Indigenize the curriculum, but also wanting it to be authentic and not [practice] cultural appropriation.”

I ask Tara if there is anything that she learned from her time working directly with the Tsleil-Waututh community that is still a part of her teaching now.

Tara: A huge part of my class teaching is community and community building and making connections and connecting myself with the students and them with me and them with each other. And I think that is one of the First Nations principles, ways of being,

is connecting. And connecting to place also. Those are probably the two biggest things I've learned that I've brought.

4.5 Scott: “The How is Important”

Scott has worked as a classroom teacher at several different schools within this school district throughout his 21-year teaching career and is now in a position at a school that is a short walk from his home. He speaks of the trails through the woods where he walks daily with his dog. He has lived in this area his whole life. Demographically, he explains, this area has changed significantly over his lifetime with a noticeable increase in housing prices which he sometimes finds strange, unfamiliar in his own neighbourhood, out of synch with his lifestyle.

Like myself, Scott has worked as a classroom teacher through a period of significant provincial budget cutbacks to teaching support staff, special needs programs, arts, libraries, and extracurricular events. He articulates how this experience has shaped his teaching.

Scott: I've had to really focus hard on just working with the kids and enjoying my job and trying to tune out all the cutbacks ... I have felt pretty abandoned by the government and society over the years, to be sure, to the point where I think a lot of teachers, if they're going to continue, you let a lot of it go. And whatever you do in a school, whatever leadership you take in a school, you forget about any pride or ego or anything else you ever had, and you simply focus on the good of the children.

Scott informs me that he highly values teacher knowledge gained through experience that is used actively in practice. He refers to the term “phronesis” several times. In an email exchange a few months after our last meeting, he clarifies what “phronesis” means to him:

The way I understood phronesis in my studies was that it was the ability to take your wisdom and intellectual knowledge and apply it effectively to specific circumstances

you experience in life. That's what good teachers do, they apply good judgement, sound decision making, and effective action to all the major and minor interactions of their day. I would say the moral component of phronesis has to do with being fair, just and respectful as well as being a good moral leader and role model. You must always hold the well-being of the children in your mind and heart.

The flip side of phronesis is something we already know in our society, to reflect and learn wisdom and knowledge from our practical experiences! (Scott, personal communication, June 8, 2020)

During one of our in-person conversations, Scott uses the concept of phronesis in the context of responding to whichever students are in your class.

Scott: The Greeks have a term for a lot of the learning that I think teachers go through, good teachers, phronesis. We don't have an English term for it, but I remember coming across that term and basically the ability to take all the theory, the concepts, the ideas, but also be able to work with it in real time in practice ... You respond to what's around you ... even if you're in the same school, you have to make adjustments and changes for your class each year ... And if you're in a different school ... there are going to be different things that you're going to have to adjust and adapt to ... Certain principles of teaching will still apply, but they won't be enough. So you need more tools in your tool kit.

He extends this notion of responsive teaching to holistic teaching and students' cultural lives.

Scott: You've got to take care of kids' emotional needs, their social needs, their need to belong. Their need to feel safe. They need to feel a part of the school. And there are holistic school things beyond the teacher in the classroom that can be done too. Celebrating the culture as a school ... So it feels like your culture is part of where you're going to school too. I think whole school initiatives are also important ... regardless of a child's situation, regardless of their culture, you need to acknowledge and respect their culture and their family,

and where they're coming from. You need to have them feeling safe and secure at school ...

I often find myself listening during these conversations as Scott generously expounds on his ideas on teaching developed over the span of his career. I am reminded of the importance of teaching colleagues having the time and energy to converse, to share the stories of their experiences, and of how difficult it often was for me to find that time as a full-time classroom teacher. I invited Scott to take part in this study because we once both taught in the same school, a different one than where he is now. As I would walk by his classroom on my way home, inevitably Scott would still be there. We would share a few end-of-the-teaching-day weary words. From these brief exchanges, I came to understand that he cared deeply about his students' mathematics education. I appreciate this opportunity now to carry on our conversations. This time, we always meet in his classroom before school begins.

In a similar vein, Scott expresses his criticism for the lack of time provided to teachers for professional development and the isolation they may experience. He recognizes value in teachers teaching other teachers, sharing knowledge and skills.

Scott: One of the things I think that's really good for teachers is you can learn a lot from each other. You can take anything. And yet we're stuck in our boxes all the time ... I'm happy to share it with my colleagues. But sometimes I need to be sprung a little bit ... it's really difficult and at times expensive to release teachers ... Schools that have a staff that share and work collaboratively, share ideas, work together, a lot more is possible. But the teachers have to be in good enough shape to actually do that.

Scott sticks to this narrative thread of “good enough shape”, or as I interpret it, well-being, when our conversation focuses on mathematics education. He makes connections between providing structure through routine for the students and supporting their emotional well-being in mathematics classes. He explains to me that kids need to feel safe and have a sense of belonging to learn.

Scott: Kids need to be safe. They need to have rules. They need to have an understanding of what’s coming in the day and feel comfortable in their learning environment ... I’m really big on work habits ... To be good at math or anything, you have to be able to focus and concentrate and practice meaningfully with it. And I believe, as I said before, all kids can be successful with math ... If you can get the kids to pay attention and work hard and do their best, it is interesting how quickly kids can pick stuff up.

This idea in Scott’s narratives of providing structure as a way of caring resonates with my own experiences of teaching and of parenting my two boys. I have also found this approach particularly valuable with young people who are anxious, not supported in other areas, or going through transition periods. I notice that it is difficult for Scott and I to talk specifically about the period of time when we worked in the same school where and when there was a lack of support for the number of students with designated learning challenges. I remember that during one of those years, my class included 13 out of 24 students with Individualized Education Plans. I felt constantly overwhelmed and insufficient. I did not feel there was adequate funding for the support that was needed. Additionally, Scott and I worked with many students who were experiencing intergenerational trauma as a legacy of residential schools for the local Indigenous community. We both become glassy-eyed and choke up when these conversations are broached.

He explains to me how he looks to self-regulation as a strategy to help all students practice mathematics.

Scott: I think it's mostly just work habits if they actually focus and concentrate and calm down, learning becomes possible. So when I look at math instruction, much like I do any subject, really, I want the kids calm in the Green Zone focused and ready to learn and want it ... My whole career is built around self-regulation and getting kids in the learning zone ...

On our third visit, I ask Scott about his connections to this place where he teaches. He shows me the hanging ivy plants that he brought to his classroom and expands on his relationship to this particular school.

Scott: There's a comfort in the school. The grounds are similar to the ones I had at [a different elementary school that he attended as a student]. You know, you have forest and lots of space ... So there's a comfort in the sameness.

He confides in me that he likes going down to the ocean, a ten-minute drive from here, as a way of relaxing.

Scott: I like the ocean, so personally I like to drive down the low road ... Sometimes there's some beautiful sun on the water and stuff. So [I] try to take some deep breaths, listen to some tunes or even turn the radio off.

By way of a personal story of changing schools as a young teenager, Scott relays to me his understanding of the anxiety that students may hold as a result of changing schools and parental expectations. "The amount of anxiety and stress a lot of these kids hide and

are under is more than we know”, he claims. It is apparent that his strategy of focus on routine also becomes classroom management and a way of building relationships.

Scott: Give them tons of praise. Be very clear and slow things down in the early going. Give them lots of positive reinforcement. And if you get them into a nice routine where this is always the way you go about things, it becomes the norm. They get used to it ... everything comes from your routines. How do you interact with the kids? How do you expect them to interact with each other? It’s classroom management. The classroom management is much more than what people might think. And a lot of it is you, your aura, your energy, your mannerisms, lifting an eyebrow, it could be a million different things. Sometimes it’s just stopping. And those tough kids, TALK TO THEM for a minute or two. Each day ... Love them all. Connect with them all ... Doesn’t happen instantly, it takes time, Amanda, I tell the kids all the time. Do your best and I’ll always be proud of you. I value the hard work.

He comes back to these sentiments at a later time in our meetings with a statement that has lingers with me, “The ‘how’ is important”.

Scott shares his thinking on focus shifts in mathematics education policy in BC and compares them to what his sister has experienced in Ontario. He advocates for a balanced mathematics program.

Scott: They [students] need it all...they need a basic balanced math program ... Different kids need more of this and less of that and vice versa. You need the basic facts. You need the computational skills, but you also need to understand the math and be able to think and reason it through and also find

the purpose in it. What is it useful for? How does it apply to the real world or just even [the] classroom?

He summarizes, “mostly they need to practice all of it until they’re strong with it because math builds”, and wonders if he is “talking too much”. Then he becomes self-conscious.

Scott: I’m probably rambling. One thing goes to another and another ...

Amanda: No, you’ve been teaching for a long time and you have experience with a lot of people, plus you’re from this area. So it’s really fantastic. And you have different schools and outdoor school.

As a Grade 6 teacher, Scott goes with his students for their week-long stay at the district outdoor school. Along with other Grade 6 teachers, Scott facilitates outdoor classes for his own students and students from other schools who are there at the same time.

I remember to ask Scott for specific examples to illustrate his approaches to teaching mathematics. He points to dodecagonal prism Chinese lanterns sitting on the Grade 5 and 6 students’ desks. “This is a Chinese New Year thing ... but we’re already doing geometry ... we’re making smaller polygons to make larger ones.”

I ask Scott about incorporating First Peoples’ knowledge into his teaching and he talks about his work leading field studies when his Grade 6 class visited the outdoor school. He tells me of the “Legend of Wountie” and mentions that he has gotten “permission from the Squamish to share it.”

Scott: There’s a mountain as you approach the big house if you’re walking on the dyke up along the Cheakamus River, you’re not supposed to point at it, but there’s actually a figure of Wountie on the mountain up near the top. There’s some trees up there and the head and the nose. So when I can, that’s where I like to tell it.

He explains that he also tells this legend back at the school when they are studying salmon and sustainability. All of Scott's examples that he shares of working with Indigenous perspectives take the form of interdisciplinary lessons or projects. His examples are related to other curricular content, such as Indigenous creation stories of Turtle Island and science studies of evolution and continents.

Scott: I definitely try and include it [Indigenous perspectives], but I try and include it when and where it seems most natural and most appropriate, and there are lots of places, but I don't try and just jam it in, in the middle of nowhere. Not that there is harm in doing that. But the longer I teach, I'm just sort of trying to get a natural flow.

When I ask about indigenizing mathematics he offers, "I don't know if it's just a First Nations thing, but the idea of people solving problems working together, which is an important part of First Nations culture, working collaboratively, solving problems."

We've gone over the forty minutes and looking at the clock on the wall I am aware that the first bell of the day will ring at any moment and be followed by a swarm of arriving students. We have already been interrupted by a few students coming in early for before-school band practice. I gather my notes and recording device, say goodbye, and make my exit, knowing that there will always be many more stories waiting to be told.

4.6 Chelsea: "It's Not That We're Changing Math, We're Just Going Deeper into the Math"

I am looking for teachers to interview for my studies and Jennifer, a long-time friend and colleague of mine, mentioned you. I am interviewing teachers about how the communities and places that they work shape the math that they teach. I firmly believe that teachers are

experts and that their stories and voices need to be a key part of research at the university. (Amanda, Email correspondence, January 15, 2020)

I would be happy to meet and talk about math! It's actually an area I have grown to be passionate about in the last couple of years, and have even "attended" online professional development sessions on this subject. (Chelsea, Email correspondence, January 16, 2020)

Within the first two minutes of our first in-person meeting, as a way of introduction, Chelsea clearly states her reason for becoming a teacher:

Chelsea: I remember exactly when I wanted to become a teacher was in Grade 1 and someone read *The Giving Tree* to our class. And it's like, "I want that. I want to be someone who inspires kids."

In this first meeting, I ask Chelsea about her experiences teaching mathematics in relation to this particular school community. She describes the surrounding school community that she lives and works in as "tight knit" where "everybody knows everybody". The parent community is "very welcoming and very involved in the school". With workshops at the school for parents that are open to teachers as well, Chelsea explains, "parents and teachers are on the same page about social emotional learning." I learn that the surrounding community also connects regularly through bake sales, garage sales, and fundraisers.

Chelsea goes on to relate to me that when it comes to teaching mathematics, however, she experiences tensions between parents' expectations and her own approaches to teaching. "They still expect worksheets to be sent home ... It's all speed and memorization." She relays to me how she is working with parents and students to change their understanding of what mathematics education can include.

Chelsea: I explained it to them [the parents] during curriculum night, "The way math looks is different from what you might be used to. Play is a huge part of math."
... I would tell them this is one way you can do math and then you talk about the

growth mindset and how your brain makes different connections all the time.

And so, when you try to do math in a different setting, then you're making that connection stronger. They're so confused at why I am teaching place value. Why do they need to know place value when they can just line up the numbers? So I think that's the biggest need is to get the parents on board with it ... It's not that we're changing math, we're just going deeper into the math.

As her narrative unfolds, Chelsea acknowledges that the parents are often "in the dark" about what the students do at school. She gives examples of strategies that she employs to help parents be informed of what students are learning.

Chelsea: I message to parents and I tell them, if you could take a photo of your child just explaining to you ... so I know that they're extending their learning here into the home, because I think that's the biggest disconnect. The kids don't bring home what they're learning.

I learn from Chelsea that at the school where she is teaching, reporting for all grade levels and all subjects has been changed in the last few years from letter grades to comments only. Previously, primary students received only comments and intermediate students received letter grades and comments for all subjects on their report cards sent home three times per year. Chelsea informs me that some parents still ask for letter grades. As we talk, she makes connections between parents' conceptions about success in mathematics being directly related to testing and grades and to parents' experiences as students in different countries. She is keen to share with me what she has been doing in her own university studies in comparative education, particularly as it relates to her students and their families.

Chelsea: I'm taking a course at UBC actually. It's called the Education of Immigrant Children ... One of my assignments was to look at another country's schooling system compared to Canada's and imagine if a student from that country comes to Canada and what would cause them anxiety or what would cause them stress. And I actually focus on Iran because I have a lot of Persian students. And in Iran, they have a lot of, from primary school, they have entrance exams ... They had to take an entrance exam to go into middle school ... If they want to go to high school, they have to take another entrance exam ... They put a lot of importance on grades ... And so here I have my students whose parents are from Iran, and they were born here. My students were born here. They're second generation ... It really opened my eyes ... I can see the impact it has on my community ... they're [the parents] still grappling with the fact that they're not going to get letter grades and it's all going to be feedback. And that's not what they're used to.

At this point in our visit, Chelsea recounts personal anecdotes of being a student and the pressure she felt from mathematics testing while growing up and going to school. She makes connections in her stories between her experience of examinations and what she perceives or has learned to be that of many of her classroom parents who went to school in Iran.

Chelsea: And then I thought about the Philippines ... there were a lot of entrance exams and the Philippines is a poor country. And so, education is basically your key to better opportunities. My parents sent me to a private school and I know they had to work really hard for that. But it's very competitive ... So, I had a good

education. But it's a very traditional education ... We had to write exams at the end of every year and grade. You actually can get held back in the Philippines.

Amanda: Did that cause you stress?

Chelsea: Oh yeah. Yeah ... I got one letter of concern and I remember like crying. I was like, I think I was in Grade 4 ... it was instilled in me.

At points during all three of our in-person meetings, Chelsea enthusiastically describes and demonstrates methods and resources for teaching mathematics that differ from her own experience as a student in the Philippines. She explains to me that she uses 'math-talks'. She points to her math-language wall, and shows me examples of numberless word problems, games, and apps. I deeply appreciate her ethic of professional sharing. Her classroom has bins of Lego and math 'tubs' for small-group hands-on engagement. I learn that her excitement over an ongoing inquiry into a multiplicity of ways to teach mathematics has not simply been driven by her experiences as a student. I listen to her first-year teaching tales of attempts to implement whole class instruction to a diverse group of students and the ensuing frustration that she felt. Trying to reach a wide range of learners, she tells me, largely accounts for her ongoing inquiry into different methods.

The afternoon of my second visit to Chelsea's classroom, another teacher pops her head in on her way home and ends up joining our conversation. The discussion turns to taking mathematics outdoors, using found materials to build with, and making star maps. Chelsea and her colleague share a passion to teach mathematics and STEM in diverse creative ways. Chelsea comments, "I think that's the goal. I think that's our goal. Like to show that it's [math learning] just happening all the time. It's just happening around you. And it's not just when you sit during that 30-minute block."

I ask about the range of learners that Chelsea had referred to in one of our earlier conversations. She thinks out loud, making connections between particular mathematics experiences and her Grade 4 students' home lives.

Chelsea: Now that I'm thinking about it, I had some kids who were really good with money because they got allowance ... And so I saw which of my kids were comfortable with the money right away ... And then I have some kids who play a lot of sports ... They're really good at counting by two's because they play basketball ... And then I also have some kids who do a lot of bake sales in this community, fundraisers. So my kids who are bakers, they're really good at fractions.

During our third meeting, Chelsea tells me about the 'classroom economy' activity that she facilitates.

Chelsea: It's a classroom management system where the kids earn based on their classroom job. And in the original one, they actually have to rent their desks ... I took out the renting part, but they do get paid every Friday. And I have bankers who pay their classmates ... when I introduced this to my class back in November, they were resistant ... For some kids, they can't separate fake money and real money and they get really nervous about losing all their money.

Chelsea notified the students' parents that this extended simulation was a part of teaching financial literacy. "I emailed this to the parents and said we're trying to do classroom economy so that they can make financial choices in a safe space."

I ask Chelsea about making connections with mathematics and Indigenous perspectives. She responds with a comment of respect, "I don't want to speak for what Indigenous culture is." She

also makes connections to school-based professional development, “We talked a lot about how you learn from your environment, so that includes nature and the classroom environment. And when I think about math, that’s what I’m trying to do, which is real-world math.” Chelsea gives an example of mathematics and Indigenous perspectives in the unit she was teaching during the month that I was interviewing her. It focused on comparing social values.

Chelsea: We’ve only started looking at First Peoples’ worldviews and comparing it to the Europeans’ worldviews. And then ... we look at trading relationships and how trade back then was interesting because there was not yet any money. There was no agreed-upon amount for certain things. It was more like “Well, in my culture this is valuable, so I’m giving it to you.” ... On Friday, I’m just going to put out artefacts in the classroom. One of them will be different coins from different countries. And what we want is basically for the kids to ask questions about those coins ... So just that idea of value and how that impacts when two groups from different perspectives ... like what happens.

Although I did not meet Chelsea until we were introduced by a colleague for this study, I do have a historical relationship to the school where she is teaching. In 2006, I was placed in the school where Chelsea works for my pre-service teacher practicum. In retelling the narrative of my visits with Chelsea, I notice my own memories of being a new teacher at this school. I remember that I was learning from my mentor teacher to communicate students’ progress in mathematics to parents using letter grades, but now comments are used. And at that time, incorporating First Peoples’ knowledge or perspectives was not a part of the Grade 7 curriculum for any subject. I reflect on how these changes in policy make Chelsea’s experiences different from mine as a new teacher and on how they shape relationships with families. I also reflect on

the critical work of teaching for curricular policy changes that reflect relationships to a community. This critical thought and action for change in mathematics education is evident in the stories of her experiences that Chelsea has shared with me.

4.7 Joan: Prioritizing Social Relationships

A mutual colleague introduces Joan to me as a potential participant for this research. At our first meeting, in February of 2020, we take the time to share and compare our own stories as teachers in the same district. In our initial meeting, we position ourselves within the layered narratives of schools, communities and the district, looking for commonalities. It turns out that we both taught at the same school in the past, but she left a few years before I began there. In fact, we even job-shared with the same person at different times. She asks as many questions as I do and comments, “See, I’m interviewing you. You’re supposed to be interviewing me.”

Joan has been at this particular school for the last twelve years. She appreciates it for its small size and the connection she feels to families. “It’s unique, it’s different, but I love it, and I don’t want to leave ... It’s small, which I love, so I know every kid’s name ... there’s a real personal thing here and you really get to know the families”. She explains how she makes an effort to build relationships with the parents that goes beyond reporting on student progress. Approximately sixty percent of the families at this school are members of the Squamish Nation. Joan describes some of the work that she regularly does to build relationships with families.

Joan: I always try and reach out to the parents in September. I’ll always introduce myself if I see them in the hall ... And if they don’t come around the school, and for some families it’s a complicated relationship, I’ll call them. And I’ve always tried to do intake interviews ... I’ll say, “Tell me about your kids. How can I help them? What

do you want from me?” So I kind of make it really relaxed. Because I think sometimes people feel like it’s going to be punitive every time they meet with the teacher. So I try really hard to have a connection ... I try to get over that barrier of them and us.

She also welcomes parents to share in classroom teaching: “I have had lots of parents come in and share their knowledge ... We’ve just been really lucky at the school because we have so many kids whose parents are involved”.

I learn from Joan that she grew up and still lives in a neighbouring community. Her mother once taught at this school.

Joan: I feel connected to this place. I grew up on the North Shore, so I love being close to the ocean. I love being close to Capilano River. This area is called Xweme’lch’stn, and what that means in Squamish is ‘crazy river’. So it’s actually where the river meets the ocean, and the ripples between them as the river rushes into the sea.

She describes the place of the school and how it is a part of the lives of this community.

Joan: This was a blueberry field ... one of the parents did the carving out front of the woman picking the blueberries ... And we have lots of really nice cedar trees on the property that we’ve used for some ceremonies and we have some incredible cherry trees over on the other side which are just so beautiful ... We’ve also got a brand-new playground which some of the kids did some designing with. If you look at the ground, there’s some First Nations canoe pictures ... And actually, the playground is named after an old EA who used to work here.

While talking about connection to this place, Joan includes the inside of the school, describing a recent massive clean-out and purchase of natural wood furniture and toys for the kindergarten classrooms. “There’s lots of room ... it’s clean ... you can find a quiet space.”

Joan’s anecdotes include shifts in her practice that have been the result of changes in administration and in curriculum policy implementation over the years of her career. With this long-term perspective, or maybe because of it, she maintains a flexibility and willingness to try new things. In response to a school-wide program change planned for the fall of 2021, she tells me, “I’ve been a teacher 22 years, so this is going to be totally new and different. But, part of me is kind of psyched.”

As I reread the transcripts of our conversations, I begin to notice a narrative that weaves consistently throughout Joan’s stories, despite recurring instances of changes and interruption to teaching imposed from the outside. It is a narrative of prioritizing social relationships in education. This includes student learning as well as teachers working together for the benefit of one another and their students. I recall that during our first interview she explained this as a priority for her in education: “If you have good social skills, you’re always going to have a friend and you’re always going to have a job.”

Joan shares an example of teaching mathematics collaboratively with a method of ‘podding’ that was practiced in the past at her school. This involves multiple teachers and EAs combining classes and teachers working with smaller groups of students from different classes at their own level. It also involves communication and cooperation between teachers, support staff, and administrators.

Joan: We’d do assessment of all the kids from [Grades] 1 to 3, or k to 3, then we’d all teach math at the same time and we’d pod them ... We podded by ability, and I

loved it because you got so much more done. You could target exactly where you were, and the kids were all in a similar place. You could go at similar pace. And I thought it was brilliant.

During our first conversation, Joan shows me photographs of her work with her current Grade 2 and 3 students outside.

Joan: [scrolling through photos] I did a big unit on times tables. The kids, they collect what they collect, some collected sticks, some did stones, some did leaves, that sort of thing ... I've done counting with little kids ... We do math a lot with sidewalk chalk outside .. So, eleven plus eleven is twenty-two and then showing it, different groupings.

Amanda: I like how they line them all up. This looks like a big bean or something.

Joan: Someone's obviously got a hold of the camera here [new photo]. Oh, there's our hopscotch. So that was counting. That was hopscotch by fives.

Amanda: That's a great idea.

Joan: [new photo] They had to do patterns from outside. I guess that's brown, green, brown. So abbabbab. That one would be ababababab. That [new photo] was our garden that we grew sunflowers. Anyways, so if that gives you an idea of some of the stuff we do outside ... I really like teaching math and I take it outside as much as I can.

Figures 4.3 and 4.4

Students Using Skip Counting to Make Hopscotch Game Squares and An ababab Pattern of Brown and Green Collected Leaves



During our second meeting, I hear about Joan's lessons for financial literacy.

Joan: We just got this new box of money. And I absolutely love it because it's got all the new bills ... I have enough that they can all touch it and feel it ... Yesterday, actually, we did a store. I set up a store in the classroom and I even had a loaf of bread that I sold ... they were all over it. They were making change. They were doing all the stuff that they wouldn't do on a worksheet.

She explains how this activity is one of the ways that she tries to relate mathematics to real life.

Money is "really important ... You need to know how to count if you're going to the store ...

When you have a job, you need to be able to count your paycheque.” She teaches her students about money and early trading between First Peoples and Europeans.

Joan: For money, I taught them about how when the Europeans first came over, we didn’t have money so we did trading. So then trading the furs for a rifle or a blanket. And then that the furs morphed into the ‘made beaver’, which was the first coin ... And they called it a made beaver because it’s a fur that’s been skinned and dried and stretched. It’s ready to go on the boat back to England to make a hat ... and then how one coin would be one made beaver and then another coin would symbolize five made beavers ... Maybe a rifle would be five made beavers but maybe a blanket would only be worth one. So the value of trading ... and trying to attach real life things to that, which we also did when we were pricing the stuff in the store.

My response — “There is a real financial literacy push in math” — prompts Joan to show me a class set of colourful boxes that she received from a local credit union. Each box has three sections, ‘Spend’, ‘Save’, ‘Share’, with three slots for inserting coins like a piggy bank. These boxes lead us to the following conversation:

Joan: We’re supposed to talk some about credit and savings too, which I think is a hard topic ...

Amanda: Do you see there being lifestyle values or something attached to this?

Joan: Mm hmm ... Not everyone has money to share. Or I guess everyone has money to share. But maybe they’re ...

Amanda: Well, there’s other things to share besides money.

Joan: This is very Eurocentric.

Amanda: Yeah. And very materialistic, but also very much valuing money. Money is the value.

Joan: Not love. Not caring.

Amanda: Prioritizing money as a value and connecting it with words like save and share is interesting, huh?

On the day of our third meeting, I spend the morning working at the library downtown, collecting land-related mathematics teaching resources for a different research project that I am involved with at UBC. When I see Joan at the end of the school day, I decide to bring out some of the picture books that I have found. As we pour over *Taan's Moons: A Haida Moon Story* (Gear, 2014), she turns to the large student calendar over the carpeted meeting area in her classroom and points out the names of the months written in Squamish language. "Youngest moon is January because it's the shortest moon," she explains. "Now we're in Frog Song time. Soon Herring time." I thought of mentioning that months could be considered a part of mathematics, keeping track of time, but it didn't fit into the flow of our conversation so I left it.

Figures 4.5 and 4.6

The Calendar in Joan's Classroom and Squamish Language Names for Months



Every morning, Joan tells me, she begins her class with a circle. “We go to the carpet and we sit in a circle and have the lights down and a talking piece. And the talking piece is a feather or a clamshell. But if a kid brings something special in, we’ll use that.” There is a new Squamish word for each day and a question. If a student arrives after the class has begun, they let the people in the main office know they are here and are given a slip to take to their teacher that reads, “Ta new, chexw tl’ik! (Hi, you have arrived!)”.

CHAPTER 5: RESONANT NARRATIVE THREADS

In phase two of the data analysis for this study, I reread all of the Individual Narratives, one after the other, with the aim of finding shared narrative threads. Through this process, I identified six distinct RNTs:

- Teachers' own experiences of learning mathematics shape their pedagogical approaches.
- Personal philosophies and passion for teaching are clearly articulated.
- Connections between mathematics and place are made through outdoor teaching experiences.
- Teachers express concern for the holistic well-being of the students.
- Attention is given to responding and reaching out to parents in the community.
- Teachers balance respect for protocols with responsibility to incorporate Indigenous knowledge and perspectives into their mathematics classes.

The RNTs are significant findings of this study in that they compare the participants' responses to some of my prepared questions of relationship with community and place in mathematics. They also reveal unexpected patterns in teachers' storied experiences. For example, "A shared concern for student well-being in the context of mathematics education" is a recurring narrative theme that I could not have predicted. In this chapter, I describe the RNTs that I found and back them up with a listing of when and how they occur in each of the participant teacher's Individual Narratives.

5.1 Teachers' Own Experiences of Learning Mathematics Shape Their Pedagogical Approaches

This narrative theme resonated soundly within all seven of the Individual Narratives. Each teacher could explain how their own positive and negative experiences as mathematics students shaped their own approaches to teaching.

- *Greg's Individual Narrative* - Greg explains that math was taught to him in a “mechanical” way devoid of meaning. As a teacher, he attempts to apply mathematics education to real-life situations or meaning in the students’ lives.
- *Joan's Individual Narrative* - Joan shared her stories of struggling in mathematics as a student, believing that she was not “good” at math. As a teacher, she explains that she learned ways to do mathematics using methods and ‘tricks’ that hadn’t been shown to her before. She also realizes that she always needed to work at her own pace. Now, she enjoys teaching mathematics with the insights of individual need that she has gained.
- *Alison's Individual Narrative* - Alison added another layer or meta-conversation to the narratives by telling me that her lack of struggling with learning math might mean that she has less insight into the different needs of her students.
- *Scott's Individual Narrative* - A change in schools meant that Scott experienced some gaps in the content he was taught. This led to difficulty in an otherwise successful experience as a math student. As a result, Scott approaches math education as cumulative and values disciplined practice. He also believes that students need a “balanced math program” with skills and applications.
- *Chelsea's Individual Narrative* - The story of examinations that determined whether students would move to the next elementary grade level was a significant part of Chelsea’s description of her experiences learning mathematics at a private school in the Philippines. She also told me a story of tears brought on by anxiety about a mark on an exam in Grade 4. As a teacher, she is supportive of her school’s new practice of not giving letter grades in the intermediate grades.
- *Claire's Individual Narrative* - One year in high school, Claire relays to me, she had a very difficult time in a mathematics class. Later she realized that her success depended on how well she understood a teacher’s particular approach. This experience contributed to her firm belief in teaching mathematics in many different ways, and the teacher’s responsibility to find a way that suits the student.
- *Tara's Individual Narrative* - Tara shares with me stories of difficulty learning school math and also being singled out to stand at the board and finish her work while others played. Her pedagogical approach to teaching mathematics includes specific attention to understanding math in concrete ways using manipulatives and also play as learning.

5.2 Personal Philosophies and Passion for Teaching Are Clearly Articulated

I asked each participant teacher near the beginning of our first meeting what led them to become a teacher. The clarity and intention in all the teachers' responses created reference points for the unfolding of the overall narrative of our shared stories. These statements of personal philosophies for education were evident in their approaches to mathematics teaching and learning.

- *Alison's Individual Narrative* - Alison's pedagogical stance for the role of teacher as facilitator or "guide on the side." She explains, "I feel that when students construct knowledge on their own they're making those connections more deeply."
- *Tara's Individual Narrative* - Tara clearly articulates, "My belief is that we're all learning together and that the students have just as much to share with me as I do with them and that we are co-creating our learning together."
- *Chelsea's Individual Narrative* - Chelsea tells me that as a teacher she "wants to be someone who inspires kids." She traces this realization back to an experience she had as a grade-one student being read *The Giving Tree*.
- *Joan's Individual Narrative* - Social skills are the priority for Joan in education. She states, "If you have good social skills, you're always going to have a friend and you're always going to have a job."
- *Greg's Individual Narrative* - As we were walking alongside the Mamquam River, Greg tells me the story of students' experiences releasing salmon fry and how his experience as an outdoor education teacher has led him to value authentic connection with the natural world as the most valuable part of outdoor education.
- *Scott's Individual Narrative* - Scott is passionate about being in education "for the kids". He explains how working through provincial budget cutbacks solidified his philosophy, "You forget about any pride or ego or anything else you ever had, and you simply focus on the good of the children."

- *Claire's Individual Narrative* - Claire shares with me the story of being inspired to become a teacher by a high school drama teacher who “really took care of us”, “made it fun”, and “was understanding of everyone.”

5.3 Connections Between Mathematics and Place Are Made Through Outdoor Teaching Experiences

The outdoor school discussed by participants in this study provides teachers working with Grades 3 and 6 students the opportunity to experience teaching in an outdoor setting. Greg and Scott make connections between those experiences and mathematics education. Other teacher participants told me about experiences or ideas for connecting mathematics teaching and learning with place by taking lessons outside close to their schools.

- *Scott's Individual Narrative* - Scott offers an anecdote of a connection to place experienced through lessons from a traditional Squamish story. This is an experience he has had repeatedly while acting as a field study teacher at the outdoor school. With permission of a Squamish Nation member, he has told the Legend of Wountie from beside the river in that place. From this place, the mountain that bears the name of the legend he is telling is visible. This legend, Scott tells me, is connected to the life of the salmon in the river. The telling can also become part of applied math and science lessons according to Scott.
- *Claire's Individual Narrative* - Claire describes weekly trips with her kindergarten class to a park close to her school, a place with historical significance for the local Tsleil-Waututh Nation. Traditional storytelling, language learning, and oral histories are part of her students' experiences on these outings. They are a part of her students' mathematics education through learning to count in Hunq'umin'um and working with pattern and design making on the beach.
- *Alison's Individual Narrative* - Alison tells of a field trip to plant native species in a nearby park as part of a climate study. However, we didn't speak of direct connections to mathematics.

- *Tara's Individual Narrative* - Tara shares anecdotes of teaching mathematics in the forest beside the school where she used to teach kindergarten. She tells me, "We would go out into the forest and we would gather materials and count things."
- *Greg's Individual Narrative* - Greg uses mathematics as language to describe the workings of a fish hatchery, the life cycle of salmon, seasons, and the flow of the river. However, for him the mathematics is secondary to authentic experiential relationship with the natural outdoor world.
- *Chelsea's Individual Narrative* - When a colleague drops by the room where Chelsea and I are meeting, they talk about ideas for teaching mathematics outside. This includes measuring the perimeter of the field and studying constellations. Chelsea also connects mathematics to place by observing the frequent neighbourhood garage and bake sales. She uses this observation to tap into students' interests in money and connect it with mathematics teaching.
- *Joan's Individual Narrative* - Joan describes making arrays with found objects to teach multiplication. "Last year I did a big unit on times tables. And the kids, they collect what they collect. Some collected sticks, some did stones, some did leaves."

5.4 Teachers Express Concern for the Holistic Well-Being of Students

I find this section difficult to write because the concepts of trauma, anxiety, disability, displacement, and poverty can be difficult to talk about in schools. In my experience, public school education often claims to operate on a principle of equitable access to quality education. And yet, teachers working with students, attentive to their well-being, are aware of the difficulties around disadvantage and inequity. Teachers witness the ways in which schools systematically fail to teach and learn with some students. The teachers that participate in this project share some of these difficult conversations with me. This opens our discussions to the ways in which well-being becomes a part of mathematics education.

Fostering a sense of belonging for students through attention to cultural events and ways of being in the school that mirror students' home lives was repeated in our conversations. As

well, strategies for teaching mathematics that address accessibility were brought up. Teachers also made references to school based social and emotional learning programs throughout our conversations. While these dialogues strayed from mathematics education, they were still relevant. It was widely acknowledged by the participating teachers that students' well-being was necessary and a priority for mathematics learning.

- *Tara's Individual Narrative* - Tara shares her experiences with a math strategy to support student wellness. She offers her response to student anxiety, "It really makes me focus on just like the basics ... maybe I need to just back the train up and we need to just work more and more with manipulatives."
- *Claire's Individual Narrative* - Claire's Individual Narrative includes her method of approaching mathematics in multiple ways as an attempt to support students with diverse socioeconomic and cultural histories. She is concerned about student engagement and accessibility. This includes her concern for students who do not have access to numeracy practice outside of classroom time.
- *Alison's Individual Narrative* - Alison speaks of the importance of community immigration services for the students and families of her school.
- *Scott's Individual Narrative* - Scott told me that he believes students' needs to belong and to feel safe are part of the necessary work of taking care of kids' emotional needs. He believes that providing a structure of routine and rules can help kids to feel comfortable in their learning environment and be successful in school mathematics. He also is a strong advocate of teachers talking to students personally as much as possible to build relationships.
- *Joan's Individual Narrative* - Joan's emphasis on building relationships with the school families where she teaches reflects her understanding of the importance of connection to community for student well-being. As well, she speaks of traditional connection to the land and the ceremonies that are a part of many students' sense of belonging.
- *Greg's Individual Narrative* - Greg spoke to me of the difficulties that some of his students have in mathematics when it is being taught in English and they do not understand the language. He is also concerned that some of his students may not get the

support that they need in understanding and practicing mathematical concepts because he or other teachers think that their struggles simply come down to not understanding the English used for instructions.

- *Chelsea's Individual Narrative* - In relation to stories of her experiences of anxiety as a student, Chelsea shares multiple strategies for teaching in ways that not only avoid the stress of examinations but also serve a broad range of learners.

5.5 Attention is Given to Responding and Reaching out to Parents in Community

Efforts of teachers to respond or reach out to parents was part of the conversations that I had with participating teachers. They speak of the ways that the culture and histories of families shape their interactions. This includes: tensions around connecting with parents who are learning English; making connections between the schools and families affected by the intergenerational trauma of residential schools; and cultural or social differences in parent expectations for mathematics education.

- *Joan's Individual Narrative* - Joan explains to me that meeting with parents informally at the start of the school year allows for connection outside of an agenda of traditional reporting and demonstrates the value of parent support and involvement within the school: "I think sometimes people feel like it's going to be punitive every time they meet with the teacher. So I try really hard to have a connection ... I try to get over that barrier of them and us." This is a practice that she had developed over years of experience. It is in part a response to difficult relationships between schools and the Squamish Nation community where she works that are a result of their experience with residential schools. Joan also regularly welcomes parents into the classroom to share their knowledge.
- *Greg's Individual Narrative* - Greg, who works in a school with a large transient immigration population, offers an account of involving his students' parents indirectly in classroom math activities through surveys designed by students in which the students ask their parents questions related to immigration.
- *Chelsea's Individual Narrative* - Chelsea does not want parents to be "in the dark" about what their students are doing at school. She sends parents links to math apps that they use

in class and also asks them to send her photographs of the students practicing what they are doing in mathematics at home. She uses formal parent visits to the classroom to describe her approach to mathematics, which, she explains, is often different than their expectations. As well, Chelsea attempts to understand the parents' experiences with mathematics education, particularly those who were raised and educated in Iran. She tells me that she recently completed a research project on education in Iran for a course at UBC on education and immigration.

- *Claire's Individual Narrative* - Claire also speaks of the difficulty connecting with some of the parents that is part of the legacy of residential schools for Indigenous children. She takes part in visits to the Tsleil-Waututh reserve to meet with parents and every spring to meet the staff and her future kindergarten students as a way of building continuity in their education experiences.
- *Alison's Individual Narrative* - Alison, who works in the same school as Greg, speaks of the challenges communicating with parents who are learning the English language. She describes a community immigration service association which works closely with the school and provides translators for some of her parent teacher interviews.
- *Tara's Individual Narrative* - Tara speaks of the difficulty of sharing student math learning with parents at her current school. She struggles with a desire to spend more time using manipulatives and at the same time a perception of parents wanting worksheet-type evidence. Tara acknowledges the influence of the pressure she perceives from parents on her own choices for math teaching, including prioritizing teaching in the classroom as opposed to outside.
- *Scott's Individual Narrative* - When I asked Scott about connections with the community at the school where he currently works, he explained to me how parents are very engaged and that "they really want to meet you" at the school where he currently works. He has two designated "parent reps" for his classroom that help out and take care of, in Scott's words, "probably far more than I have ever asked for." Scott stated: "I feel very secure knowing that the kids are well supported. And I like meeting the parents, too, that's just a really good feeling."

5.6 Teachers Balance Respect for Protocols with Responsibility to Incorporate Indigenous Perspectives Into Lessons

One of the limitations of this research project is that there are no participants of ancestry Indigenous to this place. The participating teachers tell me about and show me physical resources that they use to incorporate Indigenous knowledge and perspectives into their mathematics lessons. They also describe workshops they have attended. As well, all the teachers express appreciation and respect for the Indigenous knowledge holders who are a part of their students' education. These people include school staff and district teachers, Elders, and community members of Indigenous ancestry. In our conversations, the participants of this study also share their own feelings of discomfort and sense of not knowing protocols or what is appropriate that is a part of their work of engaging with Indigenous knowledge in their teaching practices. At the same time, all the teachers also express, in their own ways, a personal responsibility to engage with Indigenous knowledge in their mathematics and other school subject classes.

I use the word 'balance' to describe this RNT even though it is a place of unease or tension. I am inspired by Stó:lō scholar Archibald's (2008) writing of finding balance and harmony as a holism that involves seeing with more than one eye (8-10). The participant teachers hold their discomfort and uncertainty as part of the process of Indigenizing the curriculum, and not something that needs to be fixed.

- *Chelsea's Individual Narrative* - Chelsea states: "I don't want to speak for what Indigenous culture is." She describes the work of a local Indigenous storyteller who regularly visits her school as an example of Indigenizing curriculum. She explains to me that she feels she is at the beginning of her learning process for incorporating Indigenous knowledge and perspectives into her lessons.

- *Tara's Individual Narrative* - Tara reflects on her teaching practice in light of a recent workshop that she attended. She wants to share what she has learned at the workshop but is not sure that it is appropriate to do so. She identifies in herself “this tension between wanting to Indigenize the curriculum, but also wanting it to be authentic and not [practice] cultural appropriation.”
- *Greg's Individual Narrative* - When I ask Greg about Indigenizing the curriculum he describes the significance of the Indigenous population where he works: “There is an Indigenous awareness and presence in the school. And that is authentic, which I think is more meaningful than tokenism.” He also comments that he has difficulty making connections between mathematics and Indigenous knowledge and tends to make connections only with other subject areas.
- *Joan's Individual Narrative* - In my conversations with Joan, she shares many examples of Indigenous knowledge holders who are a part of her classroom and school-wide teaching. She speaks of the local Indigenous ceremonies and intergenerational approach to education that are present there. When we speak about teaching counting to her students in the Squamish language, she explains that this is done by a Squamish support staff in her classroom as she does not know the language. Joan also shows me a resource for social emotional learning that she is Indigenizing with an administrator at her school as a resource for the district.
- *Scott's Individual Narrative* - Scott tells me that he incorporates Indigenous knowledge and perspectives in his classroom lessons in an appropriate way by grounding it within larger conceptual frames such as teaching about origin stories. He is critical of tokenistic approaches. As well, Scott speaks at length about his work with Indigenous storytelling at the outdoor school and the protocol of asking for permission from the local Indigenous people to tell their stories to the students.
- *Alison's Individual Narrative* - Alison tells me about her realization of personal biases and ignorance about a local Indigenous community that occurred during a sharing circle activity at a school-based professional development day. This experience is offered as a reflection on the uncomfortable personal work that she sees as necessary for her in the context of Indigenizing the curriculum. She also expresses appreciation for the First Nations support staff at her school sharing cultural knowledge and practices within

classes. As well, Alison excitedly tells me about the district workshops that she has attended about bringing Indigenous knowledge into the classroom. She shows me the resources from these workshops as well as others that she has recently acquired through her school.

- *Claire's Individual Narrative* - Claire comments on the importance of incorporating Indigenous knowledge and perspectives even if she is taking a risk of making mistakes. She states: "I think the main thing that I've heard over the years from our Indigenous support workers is that it's better to try and kind of fail at it than not try at all ... It's a very slow process of finding out all these different things and ways of knowing and, you know, just trying to connect things as well ... It's a hard one."

5.7 Summary of RNTs

A difficulty for me with this phase of the narrative inquiry process was how to present, or retell, the RNTs. The identification of RNTs represents a new conversation, one between myself and the Individual Narratives. This is as close as this study comes to facilitating a conversation between all the participants at once. In fact, the RNTs that I identify could be topics for a focus group discussion between the teacher participants. A focus group is not part of the initial design of this study, and a conversation between all the participants did not seem feasible, particularly due to the realities of the Covid-19 pandemic.

In Clandinin's (2013) example of finding RNTs that I describe in the methodology chapter for this study, the research focus is on the experiences of the subjects just like in my study. Unlike my study, Clandinin's conversation to find RNTs is with a group of other researchers. There are no other researchers in my study. Along with there being no opportunity for the participant teachers to have a conversation with one another, having only one researcher is also a limitation of this study in regard to conversations of RNTs. To address this limitation, I include RNTs in the third phase of analysis, rereading them and the Individual Narratives along

with popular media and related research literature. This third phase of analysis gives attention to the institutional and popular media narrative context within which the study occurs. The findings are presented in Chapter Six.

CHAPTER 6: DOMINANT, COUNTER, AND RELATIONAL NARRATIVES

This chapter presents the findings of the third phase of data analysis for this research project. The process of analysis for this phase is a rereading of the findings for the previous two phases of analysis, Individual Narratives and RNTs, with attention to a broader social context including narratives of educational institutions and popular culture. The Individual Narratives and the RNTs are reread alongside related popular media as well as relevant research literature. As is the case in phase one and two of the analysis, the findings presented in this chapter address the primary research question for this study (see page 69).

A structure provided by identifying dominant and counter narratives creates a pathway for entering into this analysis. I chose to analyze three sites of negotiation between the dominant and counter narratives in elementary school mathematics education:

- Who can do math?
- What counts as elementary school mathematics?
- In what ways do we relate with place through mathematics education?

Pursuing the two conceptual avenues of dominant and counter narratives also allowed for an unexpected development in the discussion as I attended to teachers' experiences that lay outside of these two oppositional narrative concepts. Appreciating the agency of their own unique experiences, reflecting a collective of over 100 years of teaching experience, led to new narratives of ways to move forward in the realm of relational mathematics teaching and learning. These relational narratives were written after discussions of dominant narratives and counter narratives in social and cultural contexts, and directly address relationships in mathematics, specifically with self, with community, and with place.

The table below is a representation of the paths that I followed in my third phase of analysis.

Table 6.1 Sites of Negotiating Dominant and Counter Narratives

Sites of Negotiation	Who can do math?	What counts as math?	How can we relate with place through math?
Dominant Institutional and Popular Narratives	<i>“You’re either good at math or you aren’t”</i>	<i>Only Western universal abstract mathematics counts in school-based education</i>	<i>Mathematics delineates place</i>
Teachers’ Counter Narratives	<i>Everyone can be successful in mathematics</i>	<i>Multiple ways of thinking, acting, and being mathematical are part of elementary school education</i>	<i>Place facilitates ways of mathematical thinking</i>
Emergent Relational Narratives	<i>Teacher subjectivity matters in mathematics education</i>	<i>Histories, values, and identities inform elementary school mathematics</i>	<i>Mathematics of place involves cycles of change and return</i>

6.1 First Site of negotiation: Who Can Do Math?

6.1.1 Recognizing a dominant narrative: ‘You’re either good at math or you aren’t’

Claire: Math gets such a bad rap, right? The way that kids ... put themselves in little boxes as to whether or not they can do math ... And it’s all about that whole mindset thing that kids get stuck in. That, “Oh I’m not good at math. That’s it, I’m never going to be good at math.”

Gutiérrez (2018) explains, “schooling often creates structures, policies, and rituals that can convince people they are no longer mathematical” (p. 2). The dominant narrative ‘You’re either good at math or you aren’t’ is described and perpetuated by competitive teaching and assessing in classrooms starting in the primary grades, large-scale standardized testing, and gatekeeping examinations for higher education. This insidious system of ranking students and

schools also relies on an assumed curriculum of a universal abstract and singular version of mathematics. As Claire and other teachers participating in this study recognized, the narrative of ‘You’re either good at math or you aren’t’ strips students and teachers of the power to discover how they think and live in mathematical ways.

This judgement of mathematical ability is perpetrated by a belief that if people don’t meet success early on in schooling, “they are just not smart enough to have mastered it” (Gutiérrez, 2013, p. 47). Fear of not being ‘good’ at mathematics early on in school-based education stems from this logic. This system of belief also sets up assumptions around primary grades, and even intermediate grades, as foundational learning for all real mathematics that is to be done later on. This places a burden of teaching on K-7 teachers, and especially the primary teachers, of not missing the opportunity to master math early.

Tara told me that she thinks some of her Grade 1 students have already decided that they are not able to be “good” at mathematics.

Tara: Even at 6 years old, I think they even already know — a lot of them really like math — but I think they already even know, “Oh, math is something that I’m not good at.”

Amanda: Where do you think they get that from?

Tara: I don’t know where they get that from. I don’t know.

Tara was not able to tell me where her students’ idea of not being good at math came from, but it is something she recognizes. She shared with me her own childhood stories of struggling with math. In one instance, she remembered being alone at the board at the front of the classroom and trying to finish math questions while her classmates who had finished were allowed to play. Her narrative clearly demonstrates a division of ‘can’ and ‘can’t’ in the way that she experienced being taught mathematics. As well, it reflects a method of teaching by which students whose needs for learning mathematics were different from the majority of other students were singled

out and made to feel bad about themselves. Another participant in this study, Joan, also talks about ‘learning’ how she was not good at mathematics in elementary school, a narrative that she has transformed through her own process of teaching and learning mathematics with her students. Tara’s narrative adds significant background to her ongoing practice of teaching mathematics through play.

Students who are not judged to have appropriately learned mathematics in schools instead learn from schools that they are not able to be successful in mathematics. It could also be argued that if you manage to make it to middle or secondary school without learning that you are considered “not good” at math, the possibility of success would still be open to you. Schools presume to hold a monopoly on mathematics ability, to be the authority on who can do math and how well they can do it.

The notion of students’ misconceptions illustrates a way in which teachers may perpetuate the removal of student agency in mathematics learning and teaching (Gutiérrez, 2018).

Many teachers have been trained to anticipate the misconceptions that students have so that they can address them in their lessons. Yet, students don’t have misconceptions. They have conceptions. And those conceptions make sense to them, until they encounter something that no longer works. (p. 2)

Teaching mathematics in this way promotes a singular view of mathematics. Misconceptions are based on an expectation for the learner to see the educators’ perspective or worldview.

Standardized testing is another example of mathematics education that removes the agency of teachers and students. Two of the teachers in this study raise the topic of the province’s annual Foundational Skills Assessment. Elementary school teachers of Grades 4 and 7 students are directed to administer these standardized tests from the ministry of education each year. The Fraser Institute, described as a “right-wing think tank” (PressProgress, 2019, March

15), uses the FSA results for each school in the province to create a school ranking. Their online interactive map (Fraser Institute, 2019) is available to the public to compare schools' results at the website *www.compareschoolrankings.org*. Schools that are ranked high are represented by a green pin on the map, those in the middle with yellow pins, then orange pins, and finally schools ranked low in the province are represented by red pins. The dominant narrative presented here is that some schools are good at math and others aren't.

Even though “educators don't take the Fraser Institute school ranking seriously” (PressProgress, 2019), this online information can shape schools' reputations with parents. Tara shared with me how she worries about the expectations of parents at her school because that particular school has a high FSA ranking. Some parents at that school have even chosen to move to the area because of her school's high ranking. This dominant narrative of hierarchy in mathematical ability is entrenched in the culture of Tara's school through the provincial FSA. Tara deliberates about showing parents proof of students' abstract numeracy skills on paper or teaching in a way that makes sense to her with more hands-on and play-based learning. Her agency as a teacher is threatened by the presence of this standardized testing structure. She feels a pressure to produce quantifiable evidence of math learning to the parents which affects her teaching. This situation creates anxiety for herself and anxiety that she perceives in her students. She spoke of the mental health issues of anxiety at her school. She sees anxiety in intermediate students who strive to overachieve and in her own students whom she believes are too young to vocalize or articulate their anxiety.

Gutiérrez (2013) points to gatekeeping through tracking students and examinations as another way in which schools perpetuate the narrative of fixed or essential mathematics ability. Furthermore, highlighting or celebrating those who are successful poses as evidence of a system

that is effective (p. 47). The inequity of limiting access to schooling through gatekeeping examinations follows students beyond schooling and into the workplace. Chelsea told me of her experiences growing up in the Philippines with mathematics examinations that she had to pass to enter each new grade, even in elementary school. She confided in me her memory of panic and tears when she once got a bad midterm report in Grade 4. As she reflected in our conversations, her understanding of standardized mathematics education is complicated by her additional understanding of the role school education can play in lifting individuals and families out of poverty. Chelsea told me that she appreciates that her parents were able to work and provide her with the opportunity to attend the school that she did.

The argument for promoting students to do well in status quo school-based mathematics is the idea of school as a social leveller and that students who don't learn school math outside of school have the right as citizens to learn it in school. This was a dilemma that I faced when working with students who had no access to schooling in the refugee camps where they had been living for years before coming to Canada and to my class. I found that the notion of 'catching up' to a perceived standardized skill level was important to some of these students and to their families.

Explicit attention to the dominant system, the game, and how to succeed at 'the game' can be argued for as an ethic for equitable teaching. It is the explicit nature of this approach that is important, with attention to issues of agency for students and their families. As Gutiérrez (2013) asserts, "Even projects that focus squarely on equity issues in mathematics education often have an underlying deficit perspective in terms of trying to get more (and different kinds of) students to learn mathematics" (p. 48). As educators address issues of power, identity, and

agency with students and communities in all subject areas, conversations of how to ‘change the game’ become possible.

6.1.2 Counternarrative: *Everyone can be successful in mathematics*

Scott: And I believe, as I said before, all kids can be successful with math.

What does it mean to be successful with mathematics? Who defines this success?

Participant teachers in this study deliberated over the idea of success in mathematics. They spoke of teaching in a variety of ways to help their students find success with mathematics in a school setting. Through intentional focus on relationships with the particular students and communities they worked to create counternarratives of “Everyone can be successful in mathematics”. The teacher participants’ struggles and methods at this site of ethical negotiation open up conversations of what success means in mathematics education. Their considerations and approaches offer pedagogies that resist the dominant narrative of mathematics essential ability in only some people and are responsive to students and communities.

Gutiérrez (2018) believes that “mathematics cannot truly improve until it adequately addresses the very students who the system has most failed” (p. 2). She advocates “developing practices and measures that feel humane to those specific communities as a means to guide the field” (p. 2). This means unlearning and undoing notions of teachers always knowing the right or correct way to learn mathematics and be mathematical. It also means “recognizing hierarchies in classrooms and society and shifting the role of authority from teacher/text to other students” (p. 5). The intentional removal of knowledge hierarchies in the mathematics classroom corresponds with the philosophical stance of Ranciere (2010). This form of radical pedagogy that upholds intellectual equality is posited as a path to address issues of identity and power in education, going beyond equity issues of accessibility and achievement (Tolbert & Bazzul, 2017).

Both Alison and Tara described their pedagogical philosophies as non-hierarchical in regard to making meaning and learning. Tara stated, “My belief is that we’re all learning together and that the students have just as much to share with me as I do with them and that we are co-creating our learning together.” Her approach aligns with Greene’s (1995) belief in the importance of students’ sharing their stories, or conceptions, “not only so that we can hear them but so that they can make meaningful the birth of their own rationality” (p. 54). Alison described her pedagogical stance for the role of teacher as facilitator or “guide on the side.” She explained, “I feel that when students construct knowledge on their own, they’re making those connections more deeply.” Her approach is compatible with the inquiry-focused International Baccalaureate program that the school where she teaches has adopted.

Alison works with a highly diverse demographic of students in terms of individual cultural and personal histories. The transdisciplinary units of inquiry that she shared with me allowed for her to facilitate student explorations and meaning making in relation to their own prior knowledges, cultural values, and worldviews. An example of this is her food truck creation project which combines a business model education with design of a menu and a food truck, drawing on personal cultural values. For Alison, Tara and other teacher participants, opportunities for students to find personal meaning with mathematics through socially situated experiences is central to their practices.

A holistic view of student expression of cultural identity in the classroom is one way of approaching the criteria for success in schools. Gutiérrez (2018) writes, “Beyond being seen as a legitimate participant (a ‘doer’ of mathematics), a student should be able to feel whole as a person — to draw upon all of their cultural and linguistic resources — while participating in school mathematics” (p. 1).

Several of the teachers in this study shared with me ways in which they have considered language in the context of mathematics education. Greg and Alison notice the difficulties that teaching mathematics only in English has for English language learning students in their classrooms. Alison comments on the need for extra support, including translators, to connect mathematics learning with student home life. Greg shared his concern that English language learning students' struggles with mathematics are repeatedly taken as language-based and those students are not given the different kinds of teaching and support that they may need. Claire and Joan also shared accounts of mathematical teaching that acknowledges students' language heritage. In the instances they described, Indigenous support workers were teaching students to count in Hunq'umin'um and in Squamish, local Indigenous languages.

Teacher participants spoke to the complexity of advocating for and teaching with Indigenous knowledge and perspectives. Claire commented that she understands that it is better to try and misstep than do nothing. Her thoughts echo Barnes' (2013) ethic of responsibility for non-Māori "Pekeha" as resisting a paralysis that comes from fear of not knowing in their work with Māori people as teachers and researchers.

Borrowing from Freire (1970), Butler and colleagues (2015) discuss the concept of "limit-situation", "a situation that brings us up against the limits of our current understanding and forces us to expand our awareness" in the context of the Truth and Reconciliation Commissions Calls to Action (p. 46). They assert that non-Indigenous scholars and educators are called upon to examine their own past, present, and future "limit-situations" as a process "to enact reconciliation in our research and our teaching" (p. 46). Butler and colleagues recognize the limitation of dominant Western epistemological and ontological perspective "limit-situations" and at the same time the responsibility of "teacher educators, teachers, and teacher candidates to

become political actors, engaged citizens, within each of their particular spheres of influence” (p. 57).

Potawatomi-Lenape scholar Dion and colleague Mestizx scholar Salamanca (2014) advocate for the definition of success for Indigenous students as including the expression of their identity in schools. They write, “Most significantly they’ve taught us that students’ first need is for learning experiences that honour Indigenous presence and cultivate their capacities to know themselves as Indigenous people” (p. 161). This includes defining themselves on their own terms, and resists stereotyping. Decolonizing education requires a settler responsibility to Indigenous people of allowing space for Indigeneity, or maybe more accurately, becoming conscious of blocking space (Hunt, 2014; Dion & Salamanca, 2014). All the participants spoke of knowledge sharing by school or district Indigenous support workers. Joan tells me that she regularly invites students’ parents and Squamish Nation Elders to share knowledge in the classroom.

Archibald (2008) draws our attention to the significance of a context of holism for Indigenous storywork. In the story of “Coyote’s Eyes”, Coyote teaches lessons of the importance of balance and harmony. He has not learned to see through the eyes given to him by mouse and by buffalo and so is stumbling, struggling for balance. Seeing through all the animals’ eyes would bring balance (pp. 8-10). She writes: “An Indigenous philosophical concept of holism refers to the interrelatedness between the intellectual, spiritual (metaphysical values and beliefs and the Creator), emotional, physical (body and behaviour/action) realms to form a whole healthy person” (11). Holism is concerned with balance and harmony and is different than thinking of opposing forces of good and evil, or order versus disorder (p. 10).

In this study, teachers' Individual Narratives and their interconnecting resonant threads reflect a significant consideration of well-being for their students. These include considerations of student anxiety, basic needs, structure and predictability, quiet, and connection through conversations. This study illustrates that attention to well-being can be part of rehumanizing mathematics. The term rehumanizing intentionally connotes a response to the realities of the dehumanizing practices in education described in the previous section and the assumption that mathematics is practiced in humanizing, or humane, ways in the world (Gutiérrez, 2018).

Teachers in this study have shared with me ways in which they are beginning to recognize humanizing mathematical practices that exist in communities, in students' lives. Examples that they shared with me include teaching mathematics in connection with Hunq'umin'um and Squamish languages, drumming, storytelling, and weaving. They also spoke of intergenerational and non-individual learning practices supported by inviting parents and Elders into the classroom. These rehumanizing pedagogies privilege the humanity of individual students and their communities. They are unique to specific communities and uphold student identity, power, and agency in mathematical learning and teaching.

In British Columbia, teachers also work with provincial, district, and school policies to humanize the experience of mathematics education for students and families. One example of this that I have experienced as a Grade 7 classroom teacher is helping parents to interpret the meaning of their child's results on the FSA. The results are sent home to parents but are not meant to be school-based progress reports. This can be confusing for parents, particularly if there are existing language or culture barriers to understanding the purpose of these reports.

In our conversations, Chelsea explained to me how report cards with no letter grades have been introduced for the intermediate students at her school. Previous letter grades plus a

few comments have been replaced by more extensive comments. By virtue of form, this removes the possibility of ranking students and instead focuses on their individual learning events.

Interestingly, Chelsea also explained how the lack of mathematics letter grades on the reports is difficult for some parents. Through her own experiences growing up in the Philippines and her studies at the University of British Columbia, she proposed that some of the parents who were educated in Iran are used to grades and exams as the primary measures for educational and subsequent social success. This resonates with Gutiérrez's (2013) explanation of the power of measured success in mathematics in social contexts that privilege math- and science-based higher education and careers. Chelsea is drawing on personal and professional experience, as well as her own academic pursuits at the University of British Columbia to negotiate this site of complex social and political interaction.

6.1.3 Relating with self: Teacher subjectivity matters in mathematics education

For this study, I asked the teachers that I spoke with about their own personal histories as students generally, and then specifically as learners of mathematics. What I noticed right away was that none of the teachers needed to pause and think about their experiences as students of mathematics. Their responses were immediate and clearly articulated. As I listened, I began to appreciate that the teachers in this study had thought deeply about their own experiences as learners in the context of becoming mathematics educators.

Teacher participants spoke of how as they reworked their understanding of mathematics content, they became mathematics learners again through their own teaching practice. For example, Joan countered her story of learning that she was bad in mathematics early on in school with another story. It was a story of her realization as a teacher that she actually could do mathematics. She explained that she has learned methods to understand math and has accepted

her need to work at her own pace. As a result, she enjoys doing mathematics with her students and was excited to share stories of her practice with me.

Teachers' own experiences of learning mathematics shaping their pedagogical approaches is a narrative thread that resonates through all their Individual Narratives. In response to his own experiences changing schools and missing content, Scott told me that he is careful to provide a balanced mathematics program that does not leave room for gaps in content or student understanding. Greg teaches mathematics applied to contexts that are meaningful for his particular students. This reflects his memories of being frustrated that the mathematics he was taught was mechanical, without real meaning or context.

Listening to the participating teachers' stories, I heard ways in which they use their own experiences to relate to the communities and places where they teach. However, their experiences of learning mathematics served mainly as jumping off points or reference points as their practices became embedded in the specific communities where they practiced. It became evident that as stories of learning became stories of teaching, they again became stories of learning and so on. Their unique and changing stories traced a "curriculum-as-lived-experience" (Aoki, 1986/1991) that returned again and again to the life of mathematics curriculum as a "complicated conversation" (Pinar, 2012).

"When students and teachers are treated as if they are interchangeable with others — with little or no attention to their identities — it can feel dehumanizing," argues Gutiérrez (2018, p. 3). When teachers are directed to practice mathematics education that is dehumanizing for their students, it is dehumanizing for the teachers too. Teachers' expertise, autonomy, and ethical judgement is undermined by standardized tests and other schooling practices that perpetuate

myths of ability, do not respect the identity and agency of their students, and do not recognize the work of building relationships with students and communities.

Something Greg told me makes me wonder about common perceptions of elementary mathematics teachers:

Greg: Being an elementary school teacher who teaches all subjects, I am probably like a good majority of elementary school teachers in that mathematics is probably not my strongest subject that I teach.

Reflecting on Greg's comment, I wonder to what extent this is a dominant narrative, that elementary teachers are not 'good' at mathematics, or at teaching mathematics. As an elementary teacher myself, I feel misrepresented when generalizations are made about lack of ability or interest in teaching mathematics, and dismiss the notion as misinformed. At the same time, I am aware that many people who teach in schools after pursuing post-secondary education in mathematics choose to teach at the secondary level. I see this pattern as part of a hierarchy of intelligence for elementary and secondary school teachers as well as a hierarchy of disciplines, with mathematics and sciences above arts-related studies, as described by Gutiérrez (2013).

A holistic view of mathematics teachers' practices could echo Gutiérrez's (2018) description for students. Teachers' well-being in mathematics requires attention to anxiety and to perceived expectations that do not match their sense of self. Alison happily described to me recently completing a masters' degree in "creating a love of reading in the classroom". She explained that it stems from her own love of young adult fiction. At the time of my conversation with Alison, I wondered about the possibility of "creating a love of mathematics in the classroom" as a research topic. I also wonder how the current dominant culture of competitive leveled mathematics would allow for a teacher's love of mathematics to be expressed. Gutiérrez (2013) claims that the process of rehumanizing mathematics education "recouples it with

connection, joy, and belonging”, and that as “people are encouraged to express themselves through the practice of mathematics, they are more likely to draw upon an innate sense of aesthetics and intuition and to seek ways that are pleasing to them” (p. 4).

By inquiring narratively into the experiences of K-7 teachers, this study privileges the subjectivity of teachers and challenges the notion of universal and replaceable teachers and teaching practices. Attention to teachers’ voices is necessary for rehumanizing mathematics education. Their subjectivity and agency are vital to sustaining mathematics teachers’ interest and passion. Greene (1995) explains that if teachers are to develop a humane and liberating pedagogy, they themselves must feel engaged. She also suggests that lost spontaneity and awareness can be recovered by examining our backgrounds.

After co-writing Individual Narratives, I asked the participant teachers how participating in this study had shifted their practices and thinking of teaching mathematics. Their individual reflections are an example of ongoing critical responses to the communities and places that they engage with. Due to Covid-19, Alison and I talked on the phone. She said that this study has made her realize that she “would like to root math with place more”. Chelsea answered my question by email.

Chelsea: The one thing that got me thinking is my Classroom Economy. I talked about how students earn class money for doing classroom jobs. One of the jobs is an Officer, whose job is to give out bonuses and fines (e.g., for calling out, forgetting assignments, etc.). I’ve been reflecting on this practice and I will be removing the fines aspect come September. Instead of policing each other, I want to focus our classroom energy into building relationships that will be rooted in respect.

It is evident in this study that valuing mathematics educators’ subjectivity is necessary for teachers to be active participants in the development of their own practices. And “it is constantly under threat in schooling” by standardized testing, methods of reporting, “pro D that is

prescriptive, trend following, and universalizing” (Gutiérrez, 2018) and other school created “structures, policies, and rituals that can convince people they are no longer mathematical” (p. 2).

Teachers’ subjectivity in mathematics education is also needed to weather changes in policies and administrations. As Scott and I commiserated about teaching through provincial budget cutbacks, he resolutely shared his enduring reason and passion for teaching. He explains to me, “I’ve had to really focus hard on just working with the kids and enjoying my job and trying to tune out all the cutbacks ... you forget about any pride or ego or anything else you ever had, and you simply focus on the good of the children”. Joan tells me that she has embraced a stance of adaptability in response to policy and administrative changes that are beyond her control. However, she also makes clear to me that she will not negotiate focusing on the social in education.

6.2 Second Site of Negotiation: What Counts as Math?

6.2.1 Recognizing a dominant narrative: Only Western abstract universal mathematics counts in school-based education

Greg: It [school mathematics] becomes, “Yes, this is the operation, this is what you do, and this is how you calculate it, and this is how you get the answer”, but not understanding it deeply. And then, “What’s the meaning behind it? Why do we have to do this?”

The dominant narrative identified in the previous section, “You’re either good at mathematics or you aren’t”, relies on a static conception of mathematics. Standardized testing and gatekeeping examinations employ a singular view of what should be tested, how it should be tested, and what the correct answers are. This static sensibility of mathematics is upheld by a dominant narrative in elementary schools: “Only Western abstract universal mathematics counts

in school-based education.” Teacher participants in this study challenged the adoption of this singular conception of mathematics as they taught and learned in relationship to the communities and places where they worked.

Gutiérrez (2013) describes the mechanism by which social and political power is conferred and fortified by a singular conception of mathematics. She writes: “The production of knowledge reflects the society in which it is created, it brings with it the power relations that are part of society. What counts as knowledge, how we come to ‘know’ things, and who is privileged in the process are all part and parcel of issues of power” (p 44). Abstract universal mathematics is the knowledge system privileged on standardized tests and gatekeeping examinations in the public education system in Canada. This philosophical perspective stems from a Platonic notion of universal ideals and considers mathematics a descriptor of essential truth. The claim to an abstract truth positions abstract universalized mathematics as superior to all other notions of mathematical thinking and practicing.

A dimension of power that comes from privileging an abstract universal approach to mathematics in education is social hierarchy based on achievement in this system. Gutiérrez (2013) explains that “just as mathematics is often perceived as an arbiter of truth, it follows that an individual who masters the discipline should be imbued with a higher esteem, intelligence” (p. 49). When mathematics is taught as “all positive and unchanging”, teachers and schools are upholding universalizing mathematics and the powers its singularity and dominance confer (p. 48). Applications of mathematics that are based on universalizing mathematics and that are promoted as providing “a useful tool that all students should *want* (or need) to learn” (p. 48) create an instrumentalist extension of this dominating narrative.

Greg described his experiences of learning mathematics as alienating and lacking meaning, “Maths always seemed very mechanical and I didn’t understand the reason behind why we were doing what we were doing.” He struggled to find the usefulness and relevance of mathematics to his life. Greg’s stories of experiences as a learner of mathematics support an argument for the inclusion of social and cultural histories of mathematics in school-based education. Instead of unquestioningly promoting one way of mathematical thinking, mathematics may be viewed as social and cultural knowledge from particular worldviews, with all the related power structures. The civilization simulation unit that Alison described to me introduces students the notion of mathematics as a human endeavour with social and cultural heritage.

A conversation that I had with Joan illustrates how mathematics developed from a singular worldview is not relevant to all students. In teaching about financial literacy, Joan is troubled by the assumption of social esteem or value connected to saving and sharing money. Teaching about money in relationship to the notion of sharing, a strategy recommended by educational resources donated to her classroom by a local financial institution, did not reflect Joan’s perception of the meanings of sharing in her particular school community. The power of money as a dominating social value meant that other practices of sharing could be overshadowed or devalued. Financial literacy that is taught without examining and questioning underlying capitalist values obscures diversity in social and cultural values. It is an example of another instrumentalist approach to teaching mathematics that is oppressive and dehumanizing to those for whom it is not socially or culturally relevant.

Little Bear (2000) writes about the notion of sharing in many Indigenous cultures of Turtle Island or North America:

The Aboriginal value of sharing manifests itself in relationships. Relationships result from interactions with the group and with all of creation. Sharing speaks not just to

interchanging material goods but also, more importantly, to the strength to create and sustain “good feelings.” Maintaining good feelings is one reason why a sense of humour pervades Aboriginal societies. Sharing also brings about harmony which sustains strength and balance. (p. 79)

The focus on a group rather than an individual, notions of “wholeness and totality”, and the importance of “sharing and generosity” uphold a principle of equality for many Aboriginal communities (p. 83). Teaching about sharing through mathematics education becomes stifled, limited, and colonizing when only capitalist values are presented.

As mentioned in the previous section of the discussion, I believe that there is a common narrative of schools as the only authority for deciding who can do math. Unfortunately, a learned belief of inability in mathematics through schooling can then extend to any consideration of non-school-based activities or thinking as mathematical. For example, a student who considers themselves successful as a dancer, video game player, or gardener, all mathematical activities, may still believe that they are not able to be mathematical.

Many teachers may not feel that they have time or are encouraged to ask who benefits from the concepts they are teaching in mathematics or how students’ identities are implicated (Gutiérrez, 2013, p. 47). In an online newspaper article published in August, 2020 (Thompson, 2020), teachers in Ontario are protesting the lack of time to prepare for implementing a revised mathematics curriculum. The new curriculum is described in the article as “‘back to basics’ math strategy, incorporates learning to code, expanded learning on financial literacy and a return to memorizing multiplication tables” (para. 7) and promises to “bolster math scores” (para. 6) as well as “give hope to these students that when they graduate they can aspire to get a good paying job” (para. 10). This is an example of curricular directives for an instrumentalist approach to mathematics that is not explicit about the social values it serves and does not support teachers to

examine issues of power and identity in the curriculum skills and content that they are directed to teach.

“The fact that mathematics [and mathematics education] is a human practice means that it is inherently political, rife with issues of domination and power, just like any other human practice” (Gutiérrez, 2013, p. 40). What counts and is promoted as mathematics in schools is a potent site of negotiation encountered by the teachers participating in this study.

6.2.2 Counternarrative: Multiple ways of thinking, acting and being mathematical are part of elementary school education

Chelsea: It's not that we're changing math, we're just going deeper into the math.

There are multiple ways that the narratives of teachers in this study recounted the creation of counternarratives to a singular Western abstract universal concept of mathematics in schools. Their individual and resonant narrative threads include interdisciplinary lessons and units, culturally responsive mathematics, play as pedagogy, attention to language, and involving home and multiple generations in learning mathematics. A “broader sense of mathematics” as one pathway towards rehumanizing school mathematics (Gutiérrez, 2013) education is evident in the teacher participants’ stories. As they reflected on their relationships with students, community, and place they made connections to experiences of negotiating the possibility for more than one way to understand that mathematical thinking, acting, and ways of being are important in schools.

Interdisciplinarity

Intentional transdisciplinary projects embed mathematics learning within broader disciplinary contexts in several of the narratives shared in conversation. Alison, Greg, and

Chelsea all teach in schools that use an International Baccalaureate model of teaching within which the school year is divided into six transdisciplinary units. Greg shared with me an example of teaching data literacy in a unit that is centred on Canadian histories and immigration policies. Alison explained how she includes histories of mathematics in a unit on ancient cultures and societies. Chelsea described her experiences with integrating mathematics into a unit of inquiry.

Chelsea: Math was something I was worried about because with the units of inquiry, language arts was always in there and social studies and science were easily integrated, and with math what I noticed with my grade team at that time, it was a stand-alone.

Interestingly, mathematics is the one subject that is allowed to be taught as a “stand-alone” at the International Baccalaureate teacher’s discretion. This reflects a persistent view of mathematics as existing entirely outside of social, historical, or physical realities and a focus on abstract universal mathematics thinking and skills. Linda T. W. Smith cautions that a hegemonic agenda of disciplinarity (strict division of academic disciplines) further serves colonizing and capitalist influences in education (Smith in Smith, Tuck & Yang, 2018).

Culturally responsive

Culturally responsive mathematics education bridges mathematics and culture (Nicol, Archibald & Baker, 2010, p. 6) in relationship to place and community. It “is often aligned with more critical and radical forms of multicultural education, as it moves beyond a focus on academic achievement and attempts also to enact educational transformation” (Nicol, Archibald & Baker, 2013, pp. 74-75). Several of the teachers in this study describe ways in which they teach and learn mathematics with local Indigenous practices.

The numbers of Indigenous students in the participant teachers’ classes varied. All of the teachers in this study recognized that the places where they live and work are ancestral territories of Indigenous Nations and that local Indigenous communities contribute to education in schools.

They recounted instances of Indigenous support workers, district Indigenous teachers, parents, Elders, and students sharing knowledge in their schools generally and in the context of mathematics teaching and learning.

Alison and Joan both mentioned traditional Indigenous weaving that was offered for their students by school district Indigenous teachers and support workers. Weaving offers practice for students to learn mathematical concepts of counting, measuring, designing, and explaining. These are four of Bishop's (1988) cultural practices that are mathematical. Bishop's list, which also includes locating and playing, is included in the provincial math curriculum for each grade (Province of British Columbia, 2021). Considering mathematics as "the science of patterning" (Devlin, 1994) is another way to make connections between weaving and mathematics.

Claire described traditional Tsleil-Waututh drumming that is led by Tsleil-Waututh support workers for their whole school. She did not make connections between drumming and mathematics until she and I speculated about mathematical practices that could address social emotional growth and needs of students. The patterning of drumming entered into our conversation at this point. She recognized a possibility for the embodied patterning of drumming to be relaxing for students. Along with patterning, the practice of drumming can engage students in mathematical activities of counting and play.

As teachers, schools, and districts respond to the *Truth and Reconciliation Commission of Canada: Calls to Action* (Truth and Reconciliation Commission of Canada, 2015b) through incorporating Indigenous knowledge, perspectives and worldviews into their teaching and learning in every subject area, there are increasing possibilities for culturally responsive mathematics to find a place in school learning, and to be recognized as such.

If mathematics is not something out there (rational, universal, innately useful), separate from humans, then researchers and practitioners can learn from students and

communities (both inside and outside of school) the various meanings that can be ascribed to doing/creating mathematics. (Gutiérrez, 2013, p. 55)

Play as pedagogy

Play as mathematical teaching and learning is brought up by Claire and Tara. Tara believes that hands-on materials of any kind can lead to play. She described her experiences playing in the forest with a kindergarten class: “You can do really amazing stuff with one to ten ...We’d gather materials, count things. They would make big pictures in the forest too, and do patterning with different leaves and sticks and rocks.” This type of mathematical playing prioritizes students’ conceptions and sense making. It is grounded in interactions with the physical world and is unpredictable.

Language

“Language embodies the way a society thinks. Through learning and speaking a particular language, an individual absorbs the collective thought process of a people”, according to Little Bear (2000, p. 78). It follows that meanings for mathematical descriptors would be shaped by the complexities languages used. Little Bear gives an example of how “Aboriginal languages are, for the most part, verb-rich languages that are process- or action-oriented” (p. 78).

The notion of relating language and mathematics was woven into several Individual Narratives. Kindergarten students learning to count from a local Tsleil-Waututh member in their Hul’qumi’num language is part of Claire’s narrative. She also uses similarities of patterning concepts in mathematics and languages to teach literacy and numeracy together. Joan also shared ways of teaching students using a local traditional Indigenous language, Squamish. She showed me numbers written in Squamish language that she used for teaching with the support of an educational assistant who knew the language. Joan tells me, “I’ve done a few lessons with it, but I find them hard to say. I don’t want to teach them the wrong stuff. So she [the educational

assistant] would come in.” Joan teaches Squamish names for months of the year. Students learn about the structure of time related to the Squamish names and words, such as Tem Welhxs, Frog Song Time (see Figures 4.5 and 4.6).

Including home and multiple generations in learning mathematics

Several teachers spoke of the work that they did reaching out to families and communities and the significance of connecting school mathematics and student home life. The practice of intentional reaching out to and connecting with parents and communities is part of an awareness of multigenerational teaching and learning in the practices of several of the teachers.

Joan emphasized the significance of connecting to parents and welcoming them into her school. Her accounts of grandparents who had survived residential school speaking at an event to the whole school, the regular inclusion of Elders at school events, and parents in her classroom to share knowledge are part of her illustration of a multigenerational approach to education. This philosophy of education values the passing on of knowledge from generation to generation and privileges mathematical thinking that connects to survival and living well in a particular place.

Similarly to Joan, Chelsea explained how she highly values the connection between home and the school. The conflicting views of what school mathematics looked like was a potent and personal site of negotiation for her. Chelsea was trying to work with her parents to help them understand the benefits that she saw in teaching with a growth mindset. At the same time, she was trying to understand their perspectives and experiences as immigrants. Her own experiences learning mathematics and her belief in a growth mindset approach shaped her communications with the community of parents.

6.2.3 Relating with community: Histories, values, and identities in elementary school mathematics

Greg recounted for me the work that he did with students to understand the human side of data through collecting and analyzing their own data in the context of studying immigration and discriminating policies in Canada. He also facilitated student development of a historical consciousness that is in relation to their own lived experiences. Greg extended students' development of historical consciousness with an embodied experience of taking a walking visit to a nearby site of a former Indigenous residential school. Through this work, Greg used an approach of critical mathematics with the goal of developing within students their personal sociopolitical awareness. Using their own information as data, students become part of the historical landscape they studied. A developing historical consciousness stretches students' conception of time beyond their lives and introduces a sense of responsibility towards the place in which they live. Freire and Mecedo (1987) articulate this development of 'conscientização' as a way for individuals to recognize themselves as a part of history. It is this awakening that can then motivate individuals into action (Gutiérrez, 2013, p. 41).

When educators speak of student action, activism, or social justice as part of their program, the work of coming to understand one's own historical and political positions in society is a necessary first step (Gutiérrez, 2013). Three of the teachers in this study work with the International Baccalaureate program. Student action — “a focus on moving beyond awareness and understanding to engagement, action and bringing about meaningful change” — is a “highlighted focus” (International Baccalaureate Organization, 2017, p. 2) for all IB students. Teaching for social justice or student action in mathematics, or any subject, threatens to become

meaningless for the students participating if their voices are not privileged. Without students' voices being heard, issues of power in the teaching setting will not be examined and the content of the teaching will become a product that simply perpetuates the ideology of the educator and curriculum (Gutiérrez, 2013).

Frankenstein (2015) argues for the presentation of context in the study of data in school mathematics in order to highlight related issues of social justice. She argues,

Without this context, the real-life topic just serves as a “backdrop” for doing the maths and ignores the power of numeracy to clarify and deepen understanding of sociopolitical and economic issues. Further, without context, issues can become trivialized, and stereotypes and unstated assumptions about the “natural order of things,” about “the way the world is,” can become reinforced. (p. 293)

By bringing his students' mathematical learning into the realm of humanized data, Greg opens a site for critical engagement with students' own issues of power and identity. Making connections between immigration and colonization of Indigenous peoples in Canada addresses and complicates the responsibility of historical consciousness for his students. Ng-a-fook (2013) writes about the complex negotiation of immigration and historical place-consciousness in relation to his own narrative of immigrant family integration:

I did not question the ways in which such educational assimilation works as a process of narrative zombification for forgetting our inheritance of a colonial past. How might we then begin to advocate for a curriculum of decolonization that asks teachers and students to remember colonialism's narratives of forgetting? (pp. 8-7)

Issues of student power and identity are a part of teaching data literacy at any grade level. Tara described getting her Grade 1 students to carry out a survey at recess about preference for Jack-O-Lantern designs. When the students accidentally erased all their data, Tara gets them to do the survey again. A shortcut would have been to substitute made-up data for the students' work after their real data was erased. However, by doing the survey again, students learn with data that is theirs. They can feel a sense of agency and ownership with their own data.

Alison told me about a way that she was working with students to examine the effects of data. Her students were studying the differences in their own reactions to events represented by photographs as compared to their reactions to the same events represented by numerical data. Their inquiry was examining the power of numerical data to remove affect and human emotion from information.

The appreciation of applied versus abstract mathematics was evident in the stories that the participating teachers shared with me. It was one of the strategies used for addressing the dilemma of how to make mathematics meaningful for every student. Claire followed the lead of her kindergarten students' daily questions of "Is it Hallowe'en yet?" and helped them to create a countdown system. Chelsea looked to garage sales and basketball games that her students participated in to develop their mathematical thinking. This strategy extended to Alison's students' own designs of food trucks. The opportunity for students' own cultural values to be a part of their projects illustrates an intention to have math placed or found in a context that may be meaningful for each student. Developing this project to examine the students' cultural values in relation to the idea of a food truck business would take it a step further in examining issues of power through mathematics education.

Chambers (2008) recommends the concept of "enskillment" as part of an education of place that connects with identity. This notion works with an assumption of people being dependent on land and community in place. Development of skills that relate specifically to the land are required to survive. Intention and function are intertwined with practice in enskillment, as are care, judgement, and dexterity. Skilled practices are in relationship with specific lands and ecologies and are passed down from older generations. As well, a person may become who they are as they learn the skills necessary to live in a particular place (pp. 116-118). In the context of

mathematics, “enskillment” could become a way of thinking about how the ways in which mathematics is learned become part of students’ identities. Local Indigenous practices mentioned by participating teachers, including weaving, drumming, and storytelling, are all examples of mathematics education that responds to some of the students’ cultural identities.

Making sense of local issues of environmental or social justice issues through the use of mathematics could also be considered “enskillment”. The instance of Alison’s class planting native species of plants to prevent erosion of the land in a green space within walking distance of their school is an example. Through this action and the mathematics related in class lessons about erosion and climate change, students are given an opportunity to identify themselves as caretakers for the place where they live.

My conversations with Claire reminded me of Greene’s (1995) theorizing that imagination makes it possible to create new pathways that move beyond systems of social injustice. Greene points out that some educational “social structures limit free play of energies, authenticity, moral sensitivity” (p. 14-15) and points out that “a general inability to conceive a better order of things can give rise to resignation that paralyses and prevents people from acting and bringing about change” (p. 11). An advocate for the arts in education, Greene (1995) appreciates a conception of imagination from Dewey (1934) as a process, a gateway through which to move from past experiences into the present, “a conscious adjustment of the new and the old” (p. 272).

I appreciated Claire’s willingness to engage with me in an imaginative speculation of the connections between mathematics and social emotional learning. It was the lack of attention in her school plan to mathematics education and the recent switch of focus on social emotional learning that inspired our conversation. Resisting a paralysis, we imagined new pathways,

drawing on the old and the new. Her comments about student self-care through counting their breathing and sharing a numerical expression of levels of anxiety spurred our conversation. We imagined activities of mathematical patterning, such as puzzles and drumming connecting with a focus on social emotional learning.

6.3 Third Site of Negotiation: How Can We Relate with Place through Math?

6.3.1 Dominant narrative: Mathematics delineates place

The dominant narrative in the previous section of this discussion that assumes the implementation of a singular Western abstract universal version of mathematics in elementary school education also severely limits the possibilities for mathematics in relationship with place. Within a closed universalizing system of mathematics for education, it is assumed that mathematical knowledge relates with place only as a delineating tool. The discomfort of some of the teachers in this study with the relationship of an abstract system for describing place is evident. For example, in reference to teaching about the salmon in the Cheakamus River, Greg explained to me that “the different species have different incubation periods so they all hatch in the spring”. He then went on to add that he knows “that is all mathematics within nature” but that he never points it out to his students. He expressed concern about making these connections because as a teacher, he explained, he gets “locked into [that] mathematics is about numbers and calculating and the more abstract side of mathematics”.

Davis (2018) describes the development of “particular mathematical systems and geometrically informed manners of interpreting experience and perception” (p. 9). His work speaks to this discussion’s concern of a dominant narrative in elementary school mathematics that “mathematics delineates place”. Davis examines the social and historical widespread

adoption of two-dimensional Euclidean geometry and Cartesian grids with their simplifying assumptions. He is critical of “the way these geometries continue to shape the sensibilities, practices, and structures of much educational discourse” (p. 9) and focuses on the perpetuation of their dominance in relation to manufactured living environments.

Davis (2018) articulates the relevance for education to consider a “post-structuralist assertion that meaning emerges more from what is absent, tacit, and forgotten than from what is made present, explicit, and conscious” (p. 11). This illumination is significant to this study that is concerned with the relational aspects of mathematics that live in silence behind the chorus of a competitive universalizing policy agenda. Davis also points out the limitations of post-structuralists’ focus on language. In particular, he is concerned with the ways in which we conceive and experience “the spaces we occupy” (p. 11). His vision aligns with this narrative inquiry study that focuses on storied experience.

The stifling and simplifying influences of a reductive two-dimensional, rectilinear Euclidean geometry to the construction and experience of the environments we live in, as described by Davis (2018), can be applied to schools. When I asked the teacher participants about their relationship to the places they taught, all of them spoke of the outdoor areas surrounding their schools. Only a few of them also included their school buildings. Their descriptions of the buildings were varied, but they were all phenomenological accounts. Alison told me that she appreciated the light from all the windows in her school and Joan talked about the pleasant feeling of openness in a school that had recently been decluttered. I wonder if all the teachers’ responses would have included the buildings and been more technical or abstract if I had asked them to “describe” the places they worked instead of what their “relationships” were.

Scott's response to my question acknowledged the construction design of his school, older and the same as a different school in the district where he spent a significant amount of time in as a child. Interestingly, he talked about how he enjoyed, or appreciated, the sense of familiarity this gave him. His personal memories inhabited and animated the place where he worked despite the underlying rectilinear architectural space and its universalizing intentions.

As Davis (2018) points out, Cartesian grids and linear graphing of relationships and quantified changes over time lend themselves well to exercises with pencil and paper and are a pragmatic choice for school-based mathematics education. The prevalence of linear mathematics in schools mirrors dominant ways of communicating about the places we live. For example, comparative information of Covid-19 of cases, deaths, and recoveries in different provinces in Canada are published by news agencies online as linear graphs. Another example is the application Google Maps' two-dimensional representation of the mountainous regions of the Lower Mainland of British Columbia. Changes in elevation, for instance a 300 m gain in elevation from sea level at Lonsdale Quay to the base of Grouse Mountain, may also be viewed as a two-dimensional side profile of the route on the Google Maps app.

Doolittle (2018) comments on the domination of grids for delineating place even when it does not make logical or common sense. The failure of the grid is particularly evident in the anecdote he shares of north- and south-bound roads in Saskatchewan, which were mapped out without considering the curvature of the earth. He writes, "driving north, along a grid road, one eventually reaches a correction line where one must drive east or west for a distance before resuming a northerly direction" (p. 107). He also describes the way a grid system used to create roads of Hamilton, Ontario, fails to consider the presence of the Niagara Escarpment and a 100-meter drop (p. 105).

An example of the insistence of grid delineation of place in the areas surrounding the schools in this study appears with the concept of private properties. Real estate markets ensure meticulous application of Cartesian grids. This system of land ownership suppresses the claims to traditional ancestral and unceded territories of the Coast Salish Peoples, particularly the Squamish and the Tsleil-Waututh Nations. Land claim issues must be included in the project of decolonizing and rehumanizing mathematics (Gutiérrez, 2018). The failure to consider social and political relationships of place in education is reinforced by teaching with a singular delineating vision of place solely based on Euclidean geometry and Cartesian grids.

6.3.2 Counter narrative: Place facilitates ways of mathematical thinking

I encountered a daddy-longlegs in the art supply cupboard on my first day back from winter break. An hour later, trapped under a drinking glass, this opilione became the object of our morning mathematics line of inquiry: Is it big or small? There was no consensus in the stream of tarantula, camping, and other related stories that emanated from a group of twenty-plus Grade 2s and 3s seated on the carpet in front of me. However, there was immediate agreement, almost as if they had heard it before, that we measure things in order to describe to one another exactly how big or small something is.

We took our math lesson outside in order to explore the concepts of big and small and to practice measurement with body parts or found objects employed as measuring tools. The students' experience in this exercise was embodied and in relation to the outdoor world, a mix of man-made and not. A few of them measured me with their hands. Some went into the forest at the edge of the school grounds to measure and others climbed rocks. One student found a stick and a rock and then measured one with the other, making no clear commitment to one or the other as the measuring tool.

Many of the Grade 2 and 3 students followed my instructions by measuring parts of the playground such as the slide or the climbing wall with their hands, feet, sticks, and rocks, which meant a new physical relationship to a familiar play structure. A few made a game of measuring the large wooden perimeter of the playground area, falling into a repetitive pattern of placing feet and chanting numbers rhythmically into the hundreds. In this prescribed exercise of describing familiar places with numbers the students' bodies were their technologies.

In the afternoon, we went back outside for a free play time. A small group of students planned and built a fairy house. They came to me looking for sticks within a specific range of diameter and length, articulated with hand movements, to make supporting walls over which they affixed a large brown leaf roof with an elastic band that they had found. They wandered to trees closer to the forest and picked moss for a bed in the house. A second group took up the idea of building a shelter. They found long sticks with draping moss attached and laid them across a trough made by protruding roots of an enormous dead stump leaving gaps in the top as entryways. The moss and trees became participants of these building activities.

While outside that afternoon, I had an impromptu conversation with a student about a complex structure that they had built over the winter holidays using Minecraft. Standing in the weak January sun with our feet on a slope of wet grass and leaves, I became an audience for their unseen three-dimensional structure and their online construction actions. Where was this mathematical design and building practice taking place? Was it online, on the hill that afternoon, or in our overlapping imaginings?

This anecdote that I share of my teaching experience in a Grades 2 and 3 classroom a few years ago is focused on responding to the immediate in education while thinking about how we relate with place. Relationships with the more-than-human world in educational settings allow

students to think mathematically outside of grids and graphs. Gerofsky (2018a) points out that outdoor wilderness or garden education defies the grid as “geometries of growing things and ecosystems are not linear or square” (p. 51). Much more than the lines and dots of population graphing can emerge from ecological studies that are free from reductive thinking. The movement of animals and birds and the flow of water are impervious to grids.

The counter narrative “Mathematical thinking emerges from relationship with place” resonates with research that focuses on forms of mapping and locating for people other than using rectilinear measurement systems. Ascher (1995) studies stick and shell maps of ocean water movement patterns created by people of the Marshall Islands and accompanying embodied practices of sensing the shifts of water movement while lying in a boat. Chambers (2008) works with Blackfoot Nation members to research an appropriate curriculum of place. She advocates for education of multiple literacies — including storytelling, dancing, weaving, and carving — as practices of locating and wayfinding.

In these examples, ways of locating and navigating are specific to and created with place; the ocean and its movement, sticks, shells, boats, stories, and materials for weaving are all a part of the creative practices. Barad (2006) proposes a theory of non-anthropocentric agential reality which speaks to the notion of mathematical thinking emerging from the interactions between humans and their physical worlds. She grounds her theory in the agential role of particular different pieces of apparatus in Neil Bohr’s experimental studies of light. Different tools are needed for humans to experience the presence of waves in light than those needed to observe particles in light. They cannot be observed simultaneously and are only observed with the correct tool, which acts as a participant in the experiment (Apffel-Marglin, 2011).

Barad (2006) theorizes an agential realist ontology in which “phenomena are not the mere results of laboratory exercises engineered by human subjects” but instead “produced through complex agential intra-actions of multiple material-discursive practices or apparatuses of bodily production”. She theorizes further that “these causal interactions need not involve humans” (p. 40). The play and outdoor learning described by Claire, Tara, Joan, Chelsea, Greg, Scott, and Alison are part of this sense of mathematics as inter-agential. This resonant thread of the participating teachers’ storied experiences, *Connections between mathematics and place are made through outdoor teaching experiences*, highlights the need for place-specific unmediated interactions. Although some of the teachers considered their schools as place in our conversations, they did not make connections between the buildings and place in the context of teaching mathematics. The possibility for making connections between indoor environments in mathematics (Davis, 2018) and practices of building as mathematics that responds to place (Dawson et al., 2020, p. 186) was not considered in this study.

I asked Claire: “Thinking about math as locating, so how we locate ourselves, do you talk or do any work with the students about where we live or what this land is?” She explained to me that she works with her kindergarten students to develop or experience and express a ‘sense-of-place’. She described teaching with a ‘sense-of-place’ as follows: “It has to do with the First Peoples Principles of Learning, we all exist and coexist in this place, and trying to find out what is important and what is in this area.” Her *extra-disciplinary* teaching practice includes visits to a park close to her school, storytelling, and learning the Hunq’umin’um language that has emerged with that place. Claire also told me about students practicing drawing a wolf, Takaya, with a local artist employed by the school district. She explained how students are learning shapes emerging from the land that are traditional to the Tseil-Waututh People. Claire’s approach to

teaching mathematics reflects her sense of mathematics: “Actually it’s just the basis for everything!”

Marker (2018) asks, “What if researchers in education and social science fields began an inquiry into Indigenous cross-cultural circumstances by a consideration of the meaning of the places on the landscape; the osmotic metaphysical and physical condition of these places?” (p. 2). What if teachers began inquiries into mathematical ways of thinking and acting with this awareness? Principles of interrelatedness (Archibald, 2008) and interconnectedness (Marker, (2018) that include “plants, animals, and humans, geologic forms, along with the stories that tune and shape cognition of a landscape that is also conscious of human beings”(p. 2) are guides for mathematics educators learning in the context of Indigenous knowledge and worldviews.

Language, culture, and the physical world are part of the principle of interconnectedness (Basso, 1996). These concepts are significant to the work of mathematics educators relating with place. Basso writes, in relation to his work with Apache people, that to understand meaning, all these aspects must be considered. He uses the term *place-making* to describe a “retrospective world-building”, a way in which remembering, imagination, and certain localities provoke transformation of place. Place-making is a cultural activity and “can be grasped only in relation to the ideas and practices with which it is accomplished” (p. 7). Basso writes that Apache placenames are references for structural and climactic changes in the land over time (p. 13-14); stories of placenames contain lessons of respect for the spirits of land, rocks, water (p. 17) and appreciation for the support of the land (p. 21).

Basso (1996) focuses his inquiry on how language and land interconnect for Apache people. He writes, “my discussion focuses on elements of language and patterns of speech, my purpose being to learn from these elements and patterns something of how Apache people

construe their land and render it intelligible” (p. 40). The connection between the land and people is as intimate as sharing a name, the people give a name to a place, the place supports the people and makes them strong, and the people are “known by their places” (p. 21). Basso explains his realization that using Apache place-names may be heard as quoting early ancestors and requires respect (p. 10) and is also connected to the story of giving a name to the place (p. 11).

Scott told me about leading a group of students during a visit to the outdoor school in a traditional storytelling experience as they were standing beside the Cheakamus River that resonates with some of Basso’s (1996) ideas on meaning created with places and held in names and stories. Scott was careful to tell me that he had been given permission to tell this story by a Squamish Nation member who was working at the outdoor learning centre. In our conversations, Scott made a connection between this storytelling experience and mathematical thinking about education for sustainability. The story, as Scott explained to me, told of respect for the salmon and held a lesson in not taking too many salmon from the river. There is a mountain that is seen from the spot where Scott stood with the students. The mountain is called Wountie, he told me, and reminds the people of the lesson to not take too many salmon. Scott’s experience is an attempt at working with both the dominant abstract narratives of school-based mathematics and the principle that “Indigenous knowledge systems are predicated on a common sense that experience and reality cannot be abstracted from the power of place” (Marker, 2018, p. 3).

6.3.3 Relating with place: Mathematics of place involves cycles of change and return

Then at the end of the thirteenth century the first mechanical clocks appeared on public buildings and, in towns at least, people became aware of a new quality of time ... now time was quantified and reduced to numbers. But numbers can be easily arranged on a line — which mathematicians refer to as “the number line.” So it was quite natural that, in place of cycles within cycles, time should also be strung out on a line and counted off in so many hours and minutes. Now instead of

time cycling and returning it would stretch out indefinitely from past to future.”
(Peat, 2002, p. 116)

The ease and control provided by the rectilinear grid makes it a “near universal method of organizing space time” (Doolittle, 2018, p. 102). The grid delineates time by “regularly demarcating chunks of time with clocks and calendars” (p. 103-104). However, as the participants of this study told their stories of teaching and learning mathematics in relationship to community and place, a theme of patterns and cycles of time that existed within the places they lived and worked was reiterated time and again. Their storied experiences challenged a purely abstract notion of time, untethered from place.

The traditional Squamish calendar that Joan uses in her classroom is an example of teaching about time as a cyclical place-related concept (see Figure 4.5 and 4.6). The Squamish names for the months refer to events occurring within their ancestral territory, including the appearance of the moon, the length of the days, and the cyclical movements and changes of plants, fish, and animals. For example, when I was with Joan in her classroom, it was during Tem Welhxs, Frog Song Time. The Squamish Lil’wat Cultural Centre (2019) offers a description of the significance of frogs at this time of year: “Frogs start out living in water and later move to land, so for this reason Frog symbolizes the ability of adaptation, change and transformation. Their springtime songs are a sign for our people to put away the winter activities and prepare for a new season” (para. 1).

The names of the months commonly used in schools are derived from cultural contexts including names for gods, goddesses, significant people, languages of counting, and rituals. The time of year that I visited Joan is commonly referred to as the month of February, named after an ancient Roman purification or cleansing ritual, Februa (Trustees of the British Museum, 2017). The disconnection from cultural origins of the names of months creates a sense of time that is not

connected to a place, or at least the place where it is being used. Joan commented on the connections that Indigenous names for months have with place and also the school subject connections beyond mathematics and language.

Joan: You're like, OK, right. That makes sense ... you know ... It's warm, we all know blackberry time ... salal, salmon run. You know, deer hunting, shedding ... there's a whole bunch of science lessons right there.

Other ways in which the participating teachers helped students to make connections between time and the places they lived revolved around the lifecycles of plants and animals. Claire and Greg, in particular, mentioned these connections. During my walk with Greg along the river, he told me the stories he had come to know of the ecology of animals, plants, weather, and humans that affected the spawning of the salmon, the hatching of their eggs, journeys through rivers and estuaries to oceans and their return again to spawn. For many years, Greg has lived and taught alongside the rivers of the area where we walked. As we came across bear skat, berry plants, eagles, and a person fishing, he told me of their relationships within the cycle of the local ecology. He also told me of joining others to restore a nearby estuary where the fry of the chum salmon we saw spawning would spend their first year.

My conversations with Greg about the changes in animal populations, river levels, and the interrelationships between human and other- and more-than human beings make connections between teaching ecology and mathematics. The changes he spoke of happened sometimes in weeks, such as a salmon incubation period, or up to a lifetime, as in the return of humpback whales to the Salish Sea. Reducing the changes in populations to specific numbers of a single species and using rectilinear methods of recording obscures the interconnectedness of the places where these changes are occurring. These two-

dimensional types of mathematical models in biology are not the entire account of what is occurring.

Complexity science, or nonlinear dynamics, is concerned with phenomena or “forms that are self-organizing and self-transformative” (Davis, 2018, p. 17). It focuses on “unpredictable patterned processes”. It is transdisciplinary. Fractal imagery underlying complexity science may be described as “the appearance and generation of a complex system is seen in much of the same terms as the production of a fractal image, as a matter of recursive elaboration through which collectives come to exceed the possibilities of the agents that they comprise” (p. 20). Complexity science is based on the idea that “complex phenomena must be studied at the level of their emergence” (p. 20).

Applied to education, complexity science leads to an understanding that “the descriptions of the universe are actually part of the universe” (p. 24). Davis (2018) writes: “Objective knowledge is not understood to be “out there” and subjective knowledge is not understood to be “in here”. Rather, “what one knows” and “who one is” are acted out in “what one does” (p. 24). Mathematical models become possibilities, not absolute descriptors.

Chambers (2008) describes a realization that wherever she had lived, there had always been people living there before her and that it took a very long time for the people before her to know how the land nourished them and what was appropriate to do with that land. She writes about curriculum in relation to place from southern Alberta, where, she appreciates, it has taken a long time “for the Blackfoot, the *Kangiryuarmuit*, to know *nunakut*, that is ‘our land,’ to know *hila*, that is the cosmos: the stars, the weather and the atmosphere” (p. 116). A curriculum that is responsive to place must work with “a different sense of time”, according to Chambers, and

engage with those who have lived in relationship with a particular land for a very long time. It is a sense of time extending much longer than a lesson, a course, or a lifetime.

Little Bear (2000) describes an Indigenous “holistic and cyclical view of the world” that is supported by the notion of “all things being in constant motion or flux” (p. 78). He writes:

If everything is constantly moving and changing, then one has to look at the whole to begin to see patterns. For instance, the cosmic cycles are in constant motion, but they have regular patterns that result in recurrences such as the seasons of the year, the migration of the animals, renewal ceremonies, songs, and stories. Constant motion, as manifested in cyclical or repetitive patterns, emphasizes process as opposed to product. It results in a concept of time that is dynamic but without motion. Time is part of the constant flux but goes nowhere. Time just is. (p. 78)

Teaching math patterns and measurements of time as cyclical means that the past and the future are part of the present. This approach is similar to a place-conscious philosophy for education (Greenwood, 2013) in which teachers and learners ask: What has happened here? What is happening here now? And what is appropriate to have happen here in the future? Starting with place in educational research allows for human connections to past, present, and future to commingle in complex ways. Gutiérrez (2018) describes a process of rehumanizing mathematics that illuminates ways in which mathematics that is humane are occurring in our worlds. Mathematical patterns in the literacies — such as drumming, weaving, and languages — that come from the places where people live and teach may be considered articulations of human expressions of time in relationship to a particular place.

CHAPTER 7: CONCLUSIONS

7.1 Summary of Research Process and Findings

The purpose of this study has been to inquiry into elementary school mathematics teachers' experiences of relating to community and place. The primary research question is: *In what ways are the practices of elementary mathematics teachers shaped by relationships with community and place in an urban and culturally diverse context?* I recruited seven elementary mathematics teachers working in the Lower Mainland of British Columbia, Canada for this study. Employing a narrative inquiry research methodology, I gathered data through a series of conversations with each teacher.

My conversations with the participating teachers were followed by three phases of data analysis. Phase One involved co-composing Individual Narratives with each of the teachers based on audio recordings and transcripts from our conversations, photographs, my field notes, as well as ongoing email communications. For Phase Two, I reread all of the Individual Narratives and identified Resonant Narrative Threads (RNTs) or common themes. Phase Three of the data analysis consisted of rereading Individual Narratives and RNTs along with related research literature and popular media. During this third phase of analysis I identified three sites of teacher negotiation between the needs of their students and institutional or popular notions of an abstract universalizing mathematics curriculum. These sites of tension revolve around the questions: (1) Who can do math? (2) What counts as math? and (3) How can we relate with place through math? At each site I examined dominant, counter, and relational narratives of the participating teachers as well as the institutional and broader public social contexts within which this study takes place. Findings illuminate how elementary mathematics teachers act as ambassadors for student agency, social emotional well-being, and expression of cultural identity.

7.2 Conclusions

Findings of this study indicate that in a culturally diverse urban context elementary mathematics teachers' relationships with communities and place shape their practices in the following ways:

- Teachers develop methods of reaching out to families in relationship to the specific communities where they work;
- Teachers question socio-cultural values embedded in mathematics lessons in relation to those of the communities where they are teaching;
- Teachers develop relationships with Indigenous school staff to bring Indigenous perspectives into mathematics
- Teachers implement data and statistics education to promote student agency;
- Teachers connect with cyclical patterns of the places where they work when teaching topics of time and sustainability.

Each of these contributions is grounded in teachers' storied experiences of attention to relationships with community and place. The teachers' participation in the co-composition of the research text gave them an opportunity to reflect on their own role in relationships with communities and place how these relationships shape mathematics lessons.

7.2.1 Teachers develop methods of reaching out to families in relationship to the specific communities where they work

All of the teachers in this study spoke about including parents and community in school-based mathematics education. They described methods for reaching out to families that developed in relationship to particular communities. For example, Joan works in a school with a large Indigenous student population and over the years has developed a practice of informal meetings with each family in September. She told me that her intention is to create a positive connection. She also recognizes the importance of intergenerational learning for her Indigenous students. Parents of Indigenous students and local Indigenous community members are regularly invited to participate and share knowledge in Joan's classroom.

Research in the fields of culturally responsive mathematics education (CRME) and critical mathematics education (CME) has shown how inclusion of students' home cultural practices is necessary to create a sense of belonging and opportunities for success in mathematics education (Gutstein et al., 1997; Wagner & Lunney Borden, 2015; Walls, 2006). This study contributes to the field of CRME by including teachers' reflections on how their own socio-cultural identities and personal histories influence the ways they communicate with families. For example, Chelsea told me how her own experiences of stress around mathematics testing during elementary school in the Philippines drove her desire to move away from a focus on testing and to inform parents of the benefits of her pedagogical approach. Chelsea regularly uses apps to show parents mathematics activities at school and encourages them to share activities done at home. This communication is important to Chelsea as she negotiates her growth mindset pedagogy with a parent community composed of mainly first generation Persian Canadian parents. This particular community of parents, Chelsea explained, has experienced success in mathematics education being measured exclusively through standardized examinations.

The findings of this study include how one teacher may change the ways that they reach out to and communicate with families in response to a difference of socio-cultural compositions between schools. For example, Tara shared with me that she does not take her students outdoors to play in the forest as a part of mathematics like she did in her previous school. This is because of her perception of expectations for more concrete evidence of student learning of parents in her current school. Some teachers also look to other school staff and community members to support them in reaching out to family members. An example of this is Greg and Alison relying on school staff and community immigration and refugee workers for communication with parents in a school with a culturally diverse community of English language learners.

The majority of CRME research concerned with fostering a sense of student belonging and success in mathematics focuses on a single marginalized cultural community. This study contributes to the field of CRME by engaging with teachers in culturally diverse classrooms and a culturally diverse school district. Teachers in this study work in culturally diverse communities and make connections between home and school mathematics with families through developing appropriate and effective ways of reaching out. They use social media, set up informal meetings, and rely on support staff and community organizations for language translations. They interpret parents needs for evidence of their children's participation in mathematics learning, while communicating their own pedagogical approaches, and reflecting on the influence of their own personal experiences as learners and teachers.

7.2.2 Teachers question socio-cultural values embedded in mathematics lessons in relation to those of the communities where they are teaching

As teachers in this study get to know particular communities they become aware of tensions between socio-cultural values embedded within standardized lessons and those of the students' families. Their storied experiences address Bishop's (2012) concern for a lack of research connecting socio-cultural values and mathematics education that Bishop identifies (pp. 7-8) and prevent the practice teaching mathematical as only a set of skills (1988, p. 181).

The need to examine socio-cultural values linked to financial literacy lessons was raised in conversations with both Chelsea and Joan. Joan questioned her own use of the words 'save' and 'share' in one of her lessons about money. She worried that culturally linked values of collecting and sharing things other than money would be overshadowed. Chelsea reflected on her introduction of fines during a year-long classroom simulated economy game with her students.

She informed me a few months after our three scheduled meetings that she was going to focus on building respectful relationships in the game and remove the system of fines in the future. She wanted to create a more collaborative and less competitive environment.

The anecdotal experiences that teachers shared in this study also open conversations for other teachers and researchers regarding how to respond to multiple cultural perspectives within one classroom, school, or district. Designing interdisciplinary lessons that invite students to share their families' cultural practices and values is an example. Alison's food truck project combines financial literacy, design, learning about percentages, with culturally specific food related practices. Teachers' willingness to examine the socio-cultural values embedded in their mathematics lessons and to become aware of those of the communities where they work requires a willingness to accept that all mathematics is linked to values (Bishop, 1988) and that there are cultural perspectives that they do not know. This willingness is in alignment with the principal of two-eyed seeing (Bartlett, Marshall & Marshall, 2012) as well as with the notion of an ecology of knowledges (Santos, 2014).

7.2.3 Teachers develop relationships with Indigenous school staff to bring Indigenous perspectives into mathematics

None of the teachers in this study are of Indigenous ancestry. When I asked them about their experiences incorporating Indigenous perspectives into their teaching practices some of them included activities led by Indigenous support workers at their schools. Claire described Tsleil-Waututh Indigenous support workers at her school making traditional drums with all of the teachers and leading drumming sessions with students. This conversation that I had with Claire connects the idea embodied learning of patterns through drumming and mathematics as study of patterns (Devlin, 1994). Alison and Joan described traditional Coast Salish weaving

taught to their classes by Indigenous support workers as mathematics education by making connections to concepts of design - one of Bishop's (1988) six culturally linked universal mathematical practices.

In the district where this study takes place, Indigenous support workers are employed only at schools that have large Indigenous student populations. It became clear through the teachers' stories that those who worked at schools with Indigenous support workers looked to them to teach Indigenous mathematical practices and ways of thinking to their students. This teaching support and the educational experiences for students' was dependent on the availability of Indigenous support workers and the relationships that teachers were able to build with them. Several of the participating teachers shared experiences of learning about teaching with Indigenous perspectives through visits of district-based Indigenous teachers and other educators, for example storytelling and visual art making. These visits were significant to the participating teachers' practices but they were described as isolated infrequent school-wide events as opposed to the regularity of classroom teaching with school-based Indigenous support workers.

While talking about experiences of teaching mathematics with Indigenous perspectives, the teachers spoke of uncertainty and risk. They welcomed these conversations and told me of their concern for acknowledging appropriate protocols and facilitating authentic experiences. But, they also recognized, as Claire tells me, that "it's better to try and fail, than not try at all". Dion (2008) writes about this pedagogical challenge of potential discomfort that emerges in bearing witness to difference, as teachers reflect on their individual experiences of relating with Indigenous perspectives. As educational researcher Barnes (2013), explains, a "paralysis can come about due to fear of "getting it wrong" or negative cross-cultural encounters and experiences" (p. 2). Teachers also expressed a sense of responsibility to incorporate Indigenous

perspectives as a way of responding to their Indigenous students' perspectives and also, more generally, as part of the process working towards reconciliation for the legacy of residential schools for Indigenous students.

7.2.4 Teachers implement data and statistics education to promote student agency

Teaching mathematics for social justice, synonymous with critical mathematics education (CME), so that it relates directly to students' lives introduces a dialogic approach to social justice education. In contrast, mathematics for social justice that focuses entirely on issues that do not affect the learner contribute to a banking approach to education in which students become repositories for knowledge (Frankenstein, 1983; Freire, 1970). Examples shared with me of focusing on social justice issues that students could relate to meant that teachers in this study are prioritizing student identity and agency in mathematics education contributing to what scholar and teacher Gutiérrez (2018) terms "rehumanizing" mathematics.

Critical data and statistics education in which students used their own data was a part of participating teachers' storied experiences. Greg's Grade 5 students collected and analysed their own families' immigration data as part of a transdisciplinary study of immigration statistics and policies in Canada. His lessons align with Frankenstein's (1983) argument for statistics studies to be a part of social studies courses. Introducing students to data literacy education through their own agency is also an underlying ethic in Tara's Grade 1 Jack-o-Lantern survey. Students become data gatherers by engaging with their school community. Both Greg and Tara's narratives contribute to research in mathematics education that pays attention to how students' identities and agency are impacted (Gutiérrez, 2013).

Frankenstein (2015) is concerned with individuals being able to understand how their own statistics and data are being used for corporate and industrial capitalist interests. These

sentiments are carried on in O’Neil’s (2016) exposure of the harm to individuals and groups caused by unchecked use of data and algorithms for profit. O’Neil writes,

Big data processes codify the past. They do not invent the future. Doing that requires *moral imagination* [my emphasis], and that’s something only humans can provide. We have to explicitly embed better values into our algorithms, creating Big Data models that follow our ethical lead. Sometimes, that means putting fairness ahead of profit.” (p. 204)

Alison and Greg’s work with students to track their own emotional responses to statistics represented as numbers in comparison to represented in photographs is another indication of elementary school teachers’ attention to students’ negotiation of a world that is increasingly influenced by data collection and manipulation.

7.2.5 Teachers connect with cyclical patterns of the places where they work when teaching topics of time and sustainability

A common thread found in the teachers’ individual narratives is that they take mathematics outdoors, outside of the school walls, and spend time in/with the surrounding school grounds, forest, rivers, and beaches as a way of relating with place. The relationships that the participants developed with the places that they work by taking lessons outdoors shaped how they taught mathematics. Using cycles and patterns found in local human and other-than-human events informed participant teachers’ outdoor mathematics activities such as Tara, Chelsea, Claire, and Joan’s work with gathering materials for counting and Alison and Joan’s practices of growing plants with students.

Teachers’ attention to relationships with place while building relationships with local Indigenous perspectives allowed for the emergence of a mathematics education that honours cycles of change and return in/with place. This is reflected in Joan’s teaching of Squamish language names for the months with their connections to the cycles in relationships with other and more-than-human worlds. Cycles of change and return are also expressed through local

Indigenous storytelling as part of lessons of salmon lifecycles and ecosystems that Greg and Scott teach. These teaching narratives add to mathematics education research with Mi'kmaw communities regarding their conception of time that is grounded in relationships with land and is always considering future generations (Wagner & Lunney Borden, 2015).

The participating teachers' stories of negotiating mathematics teaching in relationship to community and place provides examples of facilitating agency of place in their lessons. These shared lessons counter a popular narrative of place being delineated and dominated by an abstract two-dimensional system of grids. When I asked Claire about teaching her students the mathematical concept of locating, she told me that she works with her students to develop a 'sense-of-place' based on the First Peoples Principles of Learning (First Nations Education Steering Committee, 2021) resources provided through her school district. This involved, she explained, learning about what is important in place and how we co-exist in place.

Developing relationship to particular places, as told by the participants, opens attention to the cycles and patterns of place as mathematical learning and teaching. Concepts of time and place that challenge widespread rectilinear rationalizing in education (Davis, 2018; Doolittle, 2018; Peat, 2002) speak to the actions of teacher participants to respond to the places where they work and to attend to rehumanizing mathematics (Gutiérrez, 2018). Principles of interrelationality and interconnectivity between place, humans, and the more-than-human world (Archibald, 2008; Little Bear, 2000; Marker, 2018) guide the discussion of mathematics education that acknowledges local Indigenous worldviews and perspectives.

7.3 Implications

7.3.1 *Implications for practicing teachers and teacher education*

This study provides specific examples of teaching mathematics with Indigenous perspectives. It occurs at a time when all elementary teachers in British Columbia and many other parts of Canada are intentionally building practices of teaching with Indigenous perspectives. Teachers participating in this study shared lessons that contribute to ongoing development of curricular resources for teaching mathematics with Indigenous perspectives. However, this study offers more than a catalogue of activities. The lessons that teachers describe are enriched by detailed conversations of issues and practices arising from attention to relationships with community and place. Sharing the narratives within this study with other teachers and with student teachers will open spaces for their own ongoing conversations of relating with Indigenous perspectives in mathematics education and other school subjects. Engaging in this research has informed my conversations in the role of instructor of university mathematics education courses with student teachers. This study highlights the significance of attention to relationships and to cultural identities and histories in discussions of teaching mathematics with Indigenous perspectives.

This study acknowledges the work of school-based Indigenous support workers in teaching elementary mathematics with Indigenous perspectives. Recognition for this significant teaching role of Indigenous support workers by educational administration at school, district, and provincial levels is recommended by this study. The findings identify teaching work done by Indigenous support workers and also a lack of teachers with Indigenous ancestry. These findings, point to a need for increased educational opportunity and recruitment of Indigenous teachers.

Teachers' concern for student agency and identity as a part of data and statistics

education is illuminated by this study. I recommend teaching data literacy and statistics for social justice with particular attention to students' agency in all grade levels and development of resources for teachers. Evolving artificial intelligence data processing capabilities and capitalist interests in data manipulation (Frankenstein, 2015; O'Neil, 2016; Zuboff, 2019) indicate the urgency for students' empowerment through learning abstract data and statistics skills and also by becoming conscious of their own related issues of agency and identity.

7.3.2 Implications for future research

This study of elementary mathematics teachers' relationship with community and place has engaged in conversations about teaching with Indigenous perspectives but it did not include any participants of Indigenous ancestry. A recommendation for future research is to design a study that includes Indigenous participants. One way to do this would be to extend the study to include both teachers and support workers as participants. As there are currently relatively fewer teachers of Indigenous ancestry in the Lower Mainland of BC school district including Indigenous support workers, Indigenous school staff, and district Indigenous success teachers would provide more diverse perspectives. As well, future research could engage with local Indigenous families and community members as participants.

Claire, Chelsea, and Joan made references to Social Emotional Learning (SEL) programs that are being prioritized by many schools in their school district. We discussed how these SEL programs relate to mathematics education — a conversation that could be developed in future research. As well, findings of this study illustrate ways in which students' social emotional well-being is a key part of their participation in elementary school mathematics. Social emotional well-being includes students' sense of cultural belonging. I recommend future research to understand how practicing teachers communicate social emotional well-being to students and

families as an integral part of mathematics teaching and learning? An additional question for future research is how district or provincial standardized mathematics assessment practices can be shifted to support prioritizing social emotional well-being as a significant element of mathematics education.

I recommend future research into teaching financial literacy with attention to embedded socio-cultural values. Teachers in this study identified the importance of teaching elementary students financial literacy skills to promote healthy management of their finances. However, conversations with participating teachers revealed concern that the way in which financial literacy was being taught may obscure the students' cultural perspectives of value, sharing, and trading.

A recommendation for future research is born of this study's findings that relates place to time in elementary school mathematics. As the teachers in this study have become attuned to the cycles of change and return in the places where they teach, they include these cycles in their mathematics lessons. Findings of this study invite possibilities for interdisciplinary mathematics education resource development. These include systems of knowledge that recognize time as shaped by cycles and patterns occurring in place such as ecology, astronomy, food sovereignty, geology, and storytelling.

7.3.3 Implications for narrative inquiry research methodology

The processes of analysis used for this study extends Clandinin's strategies for narrative inquiry data analysis by including visual analysis. My analysis of patterns of participating teachers' narratives visual mapping by using stickies on a wall along with story arcs and connections drawn out on chart paper (Appendices E and F). The analytic processes of this study synthesize educational strategies of mind and concept maps (Bennett, 2001) and storyboarding

(Naicker, Pillay & Blose, 2020, p. 134) with Clandinin's (2013) narrative inquiry concepts of rereading and retelling.

This study introduces narrative inquiry data analysis processes of identifying RNTs that can inform the work of future researchers. In the second phase of analysis, it borrows from Clandinin's (2013) account of multiple researchers comparing Individual Narratives that they had each co-composed with an individual research participant. She describes their findings of RNTs that were common to all of the researchers work. My study has developed an analysis model that identifies RNTs through reading across multiple Individual Narratives co-composed by a single researcher in and multiple participants.

7.4 Closing Reflections, Reliving

My research focuses on the experiences of practicing teachers, their voices. They are the ones who show up for their students in the classroom 198 days per year. The students' lives occupy their thoughts, planning, and reflection for years. Teachers negotiate the daily ethics of bringing curriculum to children in a way that works for the students, that responds to their individual histories, identities, and dreams. Teachers struggle with failures and successes, measuring their own and the students' accomplishments and then passing students on to other teachers at the end of the year. Teachers ask: Where are you coming from and where will you go? How can I prove to you that you belong, you have limitless potential, and a capacity for success? How can I help you be confident as a creative and unique student of mathematics? Teachers tell students: Make mathematics your own practice! Find mathematics in the world around you! Bring mathematics to the world around you! Clandinin and Connelly (2000) claim that narrative inquiry is both a methodology and a phenomenon. The same duality exists for mathematics education.

Thanks to an inspirational university mathematics professor, I gained a perspective on the field of mathematics that it is like an ocean — endlessly shifting and impossible to see all at once or in its entirety. Similarly, the storied experiences of teachers in this study reflect an openness to an ongoing process of learning what mathematical thinking and practice means for their students and in the communities and places where they work. Their teaching narratives contribute to an expansive sense of the fields of mathematics and mathematics education that at the same is grounded in reflective relationships building with community and place.

Reliving is a part of the narrative inquiry research methodology cycle, coming after and before the stages of living, telling, and retelling. A process of reliving began for me as soon as I contacted teachers for this study. I began reliving my previous experiences as a teacher in the same Lower Mainland school district where they were employed. As I spoke with Claire on the day that we first reconnected, I looked up at a mural on the wall outside of her classroom that had been created by Grade 7 students while I was their classroom teacher eight years before. I came back to that school, to Claire, and to the research process for my master's degree that had been a part of the painting of that mural. Retelling and reliving are inextricably linked. Reliving occurred as I returned to visit each teacher and we picked up the conversation from our previous visit. Reliving occurred as the teachers returned to their classrooms, reflecting on our conversations. Retelling occurred as the teacher participants sent me email edits and comments for the proposed drafts of their Individual Narratives.

I began this research endeavour from a place of relationship. I immersed myself in the stories of colleagues and schools in places that I have been employed as a classroom teacher for over a decade. I took time out from the work of being a classroom teacher to engage with academic research and theorizing in the field of mathematics education and place-related

education through my doctoral studies at the University of British Columbia. I felt a need to find ways to speak to the relational work and tensions of elementary school mathematics education that I had experienced during my own teaching practice. I sought to hold up teachers' stories and their voices as those of experts in their field. I designed and carried out my study with an intention to hold up Indigenous knowledge, perspectives, and the right to self-determination within education and particularly school-based mathematics education. I hoped to further mathematics education that is alive to the necessity of learning to live well in place together, that doesn't shy away from the complexities and discomforts of education for decolonization, social justice, and a sustainable future.

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Appendix A

Research Invitation



THE UNIVERSITY OF BRITISH COLUMBIA

Faculty of Education
Department of Curriculum & Pedagogy
2125 Main Mall
Vancouver, BC Canada V6T 1Z4

Phone 604 822 5422
www.edcp.educ.ubc.ca

To: <Potential participant>
<Name of Institution>
<Address of Institution>

From: Amanda Fritzlan

Re: Invitation to Participate in Research Study

Date: March 21, 2019

Teachers' Experiences of Connecting to Community, Place, and Indigenous Knowledge in Mathematics Education

LETTER OF INITIAL CONTACT

This study is an exploration of the ways in which K-12 teachers make connections with place, community, and Indigenous knowledge in mathematics teaching and learning. It is designed to focus on the lived experiences of teachers as a way of furthering understanding the ways in which mathematics education can be responsive to social and historical elements of place in culturally diverse urban contexts.

Principal Investigator: This study will be overseen by Dr. Cynthia Nicol, UBC Department of Curriculum and Pedagogy, [REDACTED]

Co-Investigator: Research will be carried out by Amanda Fritzlan, Doctoral Candidate, UBC Department of Curriculum and Pedagogy, [REDACTED]. This study is for the completion of a doctoral degree and will be presented as a public document in the form of a dissertation.

Purpose: The purpose of this study is to explore ways in which teachers connect with community, place, and Indigenous knowledge in mathematics education.

Procedures: As a participant in this study, you will be asked to take part in interviews with the researcher about your experiences teaching mathematics. The interviews will be focused on sharing teaching stories and possibly examples of lessons.

These interviews will be audio-recorded, encrypted, and password protected. As well, photographs of the places where you teach and of materials used in teaching may be taken. There will be no photographs of people and photographs will be stored securely.

There will be three interviews, 45 minutes each, over the course of the 2019-2020 school year. The maximum total time for participation is 135 minutes

Data storage: All recordings, transcripts, and photographs will be stored digitally on password protected and encrypted computers. Hard copies will be stored in lockable filing cabinets in Dr. Cynthia Nicol's UBC office.

Potential Risks of this Study: There are no foreseeable risks associated with this study.

Potential Benefits of this Study: Engaging in a conversation about your experiences connecting mathematics to place, community and Indigenous knowledge as well as associated challenges has the possibility to enhance your teaching practice.

Anonymity and Confidentiality: The information gathered will be used for research purposes only. Identifying details will be changed and pseudonyms will be used to protect anonymity.

Dissemination of Results: The results of this study will be presented in the form of a doctoral dissertation and will be publically available online through UBC at <https://open.library.ubc.ca/cIRcle/collections/ubctheses>.

Contact for information about this study: For more information, you can contact Amanda Fritzlan, [REDACTED], [REDACTED]

Contact for Complaints: If you have any concerns or complaints about your rights as a research participant and/or your experiences while participating in this study, contact the Research Participant Complaint Line in the UBC Office of Research Ethics at 604-822-8598 or if long distance e-mail RSIL@ors.ubc.ca or call toll free 1-877-822-8598.

Appendix B

Teacher Interview Consent Form



THE UNIVERSITY OF BRITISH COLUMBIA

Faculty of Education
Department of Curriculum & Pedagogy
2125 Main Mall
Vancouver, BC Canada V6T 1Z4

Phone 604 822 5422
www.edcp.educ.ubc.ca

Teachers' Experiences of Connecting to Community, Place, and Indigenous Knowledge in Mathematics Education

INTERVIEW CONSENT FORM

This study is an exploration of the ways in which K-12 teachers make connections with place, community, and Indigenous knowledge in mathematics. It is designed to focus on the lived experiences of teachers as a way of furthering understanding the ways in which mathematics education can be responsive to social and historical elements of place in culturally diverse urban contexts.

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Co-Investigator: Research will be carried out by Amanda Fritzlan, Doctoral Candidate, UBC Department of Curriculum and Pedagogy, [REDACTED]. This study is for the completion of a doctoral degree and will be presented as a public document in the form of a dissertation.

Purpose: The purpose of this study is to explore ways in which teachers connect with community, place, and Indigenous knowledge in mathematics education.

Procedures: As a participant in this study, you will be asked to take part in interviews with the researcher about your experiences teaching mathematics. The interviews will be focused on sharing teaching stories and possibly examples of lessons.

These interviews will be audio-recorded, encrypted, and password protected. As well, photographs of the places where you teach and of materials used in teaching may be taken. There will be no photographs of people and the photographs will be stored securely.

There will be three interviews, 45 minutes each over the course of the 2019-2020 school year. The maximum total time for participation is 135 minutes

Data storage: All recordings, transcripts, and photographs will be stored digitally on password protected and encrypted computers. Hard copies will be stored in lockable filing cabinets in Dr. Cynthia Nicol's UBC office.

Potential Risks of this Study: There are no foreseeable risks associated with this study.

Potential Benefits of this Study: Engaging in a conversation about your experiences connecting mathematics to place, community and Indigenous knowledge as well as associated challenges has the possibility to enhance your teaching practice.

Anonymity and Confidentiality: The information gathered will be used for research purposes only. Identifying details will be changed and pseudonyms will be used to protect anonymity.

Open Access: The data for this study will be accessible to the public as required by funders, and journals that may be approached to publish the study. Details that would identify the participants will be removed or changed from publically accessible data and pseudonyms will be used for the participants. Once the data is made publicly accessible, participants will not be able to withdraw their data.

Dissemination of Results: The results of this study will be presented in the form of a doctoral dissertation and will be publically available online through UBC at <https://open.library.ubc.ca/cIRcle/collections/ubctheses>.

Contact for information about this study: For more information, you can contact Amanda Fritzlan, [REDACTED], [REDACTED].

Contact for Complaints: If you have any concerns or complaints about your rights as a research participant and/or your experiences while participating in this study, contact the Research Participant Complaint Line in the UBC Office of Research Ethics at 604-822-8598 or if long distance e-mail RSIL@ors.ubc.ca or call toll free 1-877-822-8598.

Consent to Participate: Taking part in this study is entirely voluntary. If you decide to participate, you may refuse to answer questions and may choose to withdraw from the study at any time. If you do choose to withdraw, any data associated with you will be destroyed.

Signature: Your signature below indicates that you have received a copy of this consent form for your own records and that consent to participating in the conversations described above. Your signature indicates that you consent to participate in this study.

Participant Signature

Date

Printed Name of the Participant signing above

Thank you!

Appendix C

Questions for Interviews



THE UNIVERSITY OF BRITISH COLUMBIA

Faculty of Education
Department of Curriculum & Pedagogy
2125 Main Mall
Vancouver, BC Canada V6T 1Z4

Phone 604 822 5422
www.edcp.educ.ubc.ca

Teachers' Experiences of Connecting to Community, Place, and Indigenous Knowledge in Mathematics Education

QUESTIONS FOR INTERVIEWS

The following questions will be used as prompts for the three interviews that will take place with each of the six volunteer teacher participants over the course of the 2019-2020 school year.

First interview: Personal histories

1. What can you tell me about your personal history as a teacher? For example: For how long and where have you been teaching? What made you decide to become a teacher? What do you enjoy about teaching?
2. What was your experience as a student? Where did you go to school? In what ways do you think you teach the same or differently than you were taught? How has education changed?
3. How was learning math for you as a young person? Do you remember any classes or events in particular?
4. What are some of your most successful strategies or lessons for teaching math? Can you show me an example? What are your biggest challenges?
5. As teachers, students often ask us why they need to learn math at all and when they will ever use it. How do you explain or show students the usefulness of math?
6. What are particular lessons that you use to connect math to the "real world" for students? How have students responded?

Second interview: Community and place

1. In what ways do you feel connected to the community that you teach with and in? What are the events that connect the school and the surrounding communities?
2. What do you see as the needs of this particular community in terms of learning and teaching math?
3. In what ways is it possible or challenging to meet the needs of this community for math education? Are there some strategies or examples that you can share?
4. In what ways do you feel connected to the place that you are teaching, the physical space of the school and the surrounding area outside of the school?

5. How does your teaching connect, or not connect with this particular place in any subject area? Can you show me some examples?
6. How is it possible, or not possible, to make these connections (with this place) in mathematics? If it is possible, can you show me some examples?

Third interview: Integrating Indigenous knowledge

1. In what ways have you observed your school district and your school integrating Indigenous knowledge into curriculum?
2. What is your experience of staff and students' responses to recently revised curriculum for integrating Indigenous knowledge?
3. In what ways do you connect Indigenous knowledge with different subject areas? What are some examples of this? How have students responded?
4. Do you see room in mathematics education for connection with Indigenous culture? If so, in what ways? Can you share examples lessons or ways in which you have done this? What are the challenges that you have experienced?

Appendix D

Timeline for Meeting with Participants

Each meeting was 45 min-1 hour long with 30-45 minutes recorded unless otherwise specified.

Meetings took place in teachers' classrooms unless specified.

Participant-Grade	Initial contact	1st meeting	2nd meeting	3rd meeting
Claire - kindergarten	Sept. 26 – met while working as TOC on Sept. 26	Oct. 22	Nov. 19	Jan. 30
Alison - Grade 7	Sept. 30 – school district email	Oct. 8	Oct. 29	Nov. 12
Greg – Grade 5	Oct. 21 – school district email	Oct. 24	Nov. 10 3 hrs – breakfast and walking along the Mamquam River	Nov. 21
Scott– Grades 5 & 6	Jan. 15 – school district email (met while working as TOC on Dec. 17)	Feb. 4	Feb. 13	Feb. 20
Tara - Grade 1	Jan. 7 – school district email (met while working as TOC on Dec. 17)	Feb. 4	Feb. 11 1.5 hrs – at a local coffee shop	Feb. 20
Chelsea-Grade 4	Jan. 15 – school district email	Feb. 10	Feb. 19	Feb. 26
Joan - Grades 2 & 3	Jan. – school district email. After email exchange with another school district teacher Jan. 17	Feb. 3	Feb. 20	Feb. 27

Appendix E

Teacher Narratives as Stickies on the Wall

