The evolution of views from a teacher perspective about participation in a mathematics professional learning community:

The project that has made math more than math

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November 2018

A thesis submitted to McGill University in partial fulfillment of the requirements of the degree of Masters of Arts in Education and Society, Math and Science Concentration (Thesis)

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Abstract

Professional Learning Communities have been shown to be effective vehicles of change for fostering school communities that value collective learning with the aim of improving school success. Multiple studies have focused on the characteristics of successful collaborations and supports for their implementation and sustainability. However, few studies have illustrated how these collaborations evolve over time, especially from a teacher perspective. This qualitative research uses a case study methodology to illustrate how teachers, in a mathematics professional learning community, changed their views about the purpose of their collaboration in a four-year project. Teacher responses from end-of-year interviews were used to conduct a constant comparative approach. A qualitative and quantitative analysis yielded the discovery of themes that show an evolution, in three phases, of teachers’ views about the nature and purpose of the professional learning community: a) the conversation, b) the collaboration with trust and c) the self-reflection via community collaboration. The study provides an analysis, through the lens of the communities of practice theory, that illustrates the progression of social learning through the development of teacher community. The results provide recommendations to inform educational leaders in the development of professional learning communities in mathematics and more broadly.
Résumé

Les communautés d’apprentissage professionnelles sont un facteur de changement qui favorise des valeurs d’apprentissage collectif dont l’objectif est d’améliorer la réussite scolaire. De multiples études ont porté sur les caractéristiques de collaboration et de soutien de leur mise en œuvre et de leur pérennité. Toutefois, peu d’études ont illustré l’évolution de cette collaboration, particulièrement du point de vue des enseignants. Cette étude qualitative fondée sur la méthodologie d’étude de cas illustre comment les enseignants de mathématiques dans les communautés d’apprentissage professionnelles ont modifié leurs perspectives sur l’objectif de leur collaboration tout au long de leur projet qui s’étalait sur quatre ans. Nous avons analysé les réponses d’enseignants lors d’entrevues de fin d’année au moyen d’une méthode comparative constante. Une analyse qualitative et quantitative a mené à une découverte de thèmes qui montrent une évolution, en trois phases, des opinions des enseignants à propos de la nature et de la raison d’être des communautés d’apprentissage professionnelles : a) la conversation, b) la collaboration avec confiance et c) l’introspection par la collaboration communautaire. L’étude fournit une analyse, dans l’optique de la théorie de la communauté de pratique, qui illustre la progression de l’apprentissage social. Les résultats peuvent être utiles afin d’informer les leaders en matière d’éducation sur le développement des communautés d’apprentissage professionnelles. De plus, cette recherche vise à soutenir et à augmenter la qualité de l’éducation des mathématiques.
Acknowledgements

To my supervisor, Dr. Marta Kobiela: Your patience, guidance and feedback, especially in the last days of editing, helped me reach my goal. I would not have made it without you. You always made me feel valued and competent. Thank you!

To my co-supervisor, Dr. Alain Breuleux: You gave me the idea to explore the CCC-M project as a thesis topic in the first place, and for that, I am very grateful. I thank you for always making me feel like a scholar, with great ideas, and inviting me to participate in academia events. Your collaborations with our school board have had positive impacts on both teachers and students. Indeed, the CCC-M project has made math more than math!

To my loving family: The sacrifice has especially been on your part. I am grateful that you have supported me through this five-year journey. I apologize for my lack of presence and participation in certain events. I cannot wait to catch-up! This graduation will be a celebration for all of us.

And, last but not least, to the incredible group of teachers in this study: As an educational consultant, I could make the assumption that you have learned greatly from my guidance. However, I can assure you, that I have learned more from you than you could ever have learned from me. I encourage you to continue rich ongoing collaborations with your peers. Thank you for these wonderful four years of participation!
Contributions of Authors

The data collected for this study originated from the Creating, Collaborating and Computing in Mathematics (CCC-M): Professional Learning Network for digital literacy and disciplinary understanding in school project led by Dr. Alain Breuleux of McGill University. I conducted the synthesis of literature and the analysis. Additionally, I wrote all the chapters in this thesis.
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CCC-M: Creating, Collaborating, and Computing in Math

CoP: Communities of Practice

CSR: Case Study Research

NCTM: National Council of Teachers of Mathematics

PLC: Professional Learning Community
“We do not learn from experience. We learn from reflecting on experience”

-John Dewey
Chapter One: Introduction

1.1 The Nature of the Investigation

This thesis examines the evolution of the collaboration that happened in a professional learning community (PLC) of mathematics teachers tackling the challenges of an educational reform. The PLC was part of a larger project, named the Creating, Collaborating, and Computing in Math (CCC-M) project. My topic aims to study teachers’ views about the purpose of their participation in the PLC. I wish to know how teachers changed their views about the purpose of the CCC-M PLC across four years of participation. As an introduction to this thesis, I will first provide some background information on PLCs. I will then present the challenges of an educational reform in mathematics. This will be followed by a description of the CCC-M project professional learning community as well as a portrayal of my professional background and premise for selecting it as a topic for my thesis. The chapter will continue by identifying the gap in literature or, more precisely, how my research aims to explore a facet less investigated by previous authors. The remainder of the chapter will consist of a research overview and chapter summaries.

1.2 Professional Learning Communities as Vehicles for Change

According to DuFour and Eaker (1988), “the most promising strategy for sustained, substantive school improvement is developing the ability of school personnel to function as professional learning communities” (Dufour & Eaker, 1988, p. ix). However, what exactly is a professional learning community? DuFour, DuFour, Eaker, & Many (2006) define a professional learning community as:

educators committed to working collaboratively in ongoing processes of collective inquiry and action research to achieve better results for the students they serve.
Professional learning communities operate under the assumption that the key to improved learning is continuous, job-embedded learning for educators. (as cited in Dufour, Dufour & Eaker, 2008, p.14)

Evidence from literature supports teachers’ change in practice. In their analysis of research articles, Vescio, Ross and Adams (2007) highlight studies that show the impact PLCs have on classroom practices and consequently student learning.

There are also certain characteristics underlying a PLC’s raison d’être, and these are, according to DuFour, DuFour & Eaker (2008), a shared mission, vision, values and goals which should all be focused on student learning, a collaborative culture with a focus on learning, collective inquiry into best practice and current reality, action orientation (learning by doing), a commitment to continuous improvement and results orientation (Dufour, Dufour & Eaker, 2008, p.15).

Similarly, Hord (2004) and Louis, Kruse and Associates (1995) have summarized, from a collective body of work, the importance of elements such as shared values and vision, collective responsibility, reflective professional inquiry, collaboration, and the promotion of group, as well as individual learning. Although not restrictive neither overly abiding to this definition and characteristics, the CCC-M PLC was initially defined by the McGill research team as a professional learning network in a broader collegial sense of the term. This will be elaborated on in the literature review of Chapter 2.

1.2 The Challenges of Educational Reform

Elementary and secondary mathematics teachers in Quebec have been faced with the challenges of implementing an educational reform since its introduction in elementary school in the early 2000s. The Quebec Education Program, Preschool and Elementary, was introduced in
2001 and the Quebec Education Program, Secondary School Education, Cycle One, was introduced in 2004. A new educational program was not only different in content but also driven by competency development. In mathematics, this meant developing mathematical reasoning, problem solving, as well as communication skills (Québec Ministère de l’Éducation, 2001a). This paradigm shift came about from an urgent need for the education system to prepare students for the 21st century.

A main impetus for the new program and change in practice stemmed from multiple reports on low achievement levels in mathematics. The trends in Quebec reflected those in the United States and Internationally (Stigler & Hiebert, 1999, NCTM, 1989; 1991; 2000). However, since the implementation of the reform, Quebec students’ results on the mathematics section of the Organisation for Economic Co-operation and Development (OECD) Programme for International Student Assessment (PISA) examination have been generally good over the years. Quebec ranked in third position overall in the 2015 PISA assessment (OECD, 2016, p.181).

Regardless of this apparent success, my consulting experience still led me to believe otherwise. The secondary cycle one June exam statistics, collected at my school board since 2010, showed low success rates in mathematical reasoning. The results were especially low in the area of more complex reasoning problems, which indicated a lack of deep conceptual understanding. To remedy, I followed the National Council of Teachers of Mathematics (NCTM) mandate, which suggests teachers should build a strong conceptual foundation and facilitate rich discourse amongst students, rather than teach rote procedures. For example, in its recent publication, Principles to Actions, NCTM (2014) highlights, as it has done in other publications, promotes ambitious practices such as:
Establish mathematics goals to focus learning […], Implement tasks that promote reasoning and problem solving […], Use and connect mathematical representations […], Facilitate meaningful mathematical discourse […], Pose purposeful questions […]. Build procedural fluency from conceptual understanding […], Support productive struggle in learning mathematics […] and Elicit and use evidence of student thinking (p. 3).

I have made it my mandate to promote and model these teaching practices in all my dealings with teachers. However, before the CCC-M project, PD had not led to much fruition.

Leaders in the area of PLCs, DuFour and Eaker (1998), believe that an education reform has failed to deliver because of five main factors: the complexity of the task, misplaced focus, lack of clarity on intended results, lack of perseverance, and failure to appreciate and attend to the change process (Dufour & Eaker, 1998, p. 13-14). In other words, change is difficult. Strategies to reform large-scale institutions and processes do exist, however, rarely are these carefully studied and implemented at an appropriate pace. Often also, there is a lack of support and vision accompanied with the ideologies of a reform. When teachers are not provided with the vision, or clarity on intended results, they lose track and give-up. Perseverance becomes difficult to maintain, especially in the context of new “in style” strategies and educational approaches. This carousel of change overwhelms teachers. In addition, it has been a failure of the system to move teachers either too quickly or too slowly during periods of change. Change is a complex process and it takes time!

1.4 The CCC-M Project Professional Learning Community

To address the challenges of the educational reform in our school board and the challenges outlined by Dufour and Eaker (1998), we collaborated with McGill researchers to implement the CCC-M project. The CCC-M project was a professional learning community
created with the purpose of enhancing the teaching and learning of mathematics using digital tools. It existed from September 2013 to June 2017. This PLC, composed of elementary and secondary teachers, educational consultants and University researchers, explored a variety of digital resources and ambitious mathematics teacher practices (as mentioned in the previous section) that are relevant to teaching and learning in mathematics. The underlying aim of the project was for teachers to not only use digital tools in the classroom, but also use them as a means to reflect on their own teaching practice for ongoing professional development within a professional learning community. As a result, the aim was for both teachers and students to develop digital literacy and improved disciplinary understanding in mathematics to lead to student success in mathematics.

The themes explored in the project were research-practice partnership, design-based research/design-based implementation research, communities of practice, professional learning network, teacher professional development, student success in mathematics, digital literacy and transition from elementary to secondary school.

As I elaborate on in more detail in Chapter 3, the CCC-M project consisted of at least four to five face-to-face meetings per year (September to May) with all participants. In addition, between these meetings, members of the group participated in additional activities, including: a) leadership team meetings between University researchers and educational consultants, b) communication between all participants on an online platform (e.g., Edmodo), c) classroom visits by the research team and consultants, and d) classroom visits by other teachers with the intent of learning from one another (peer observation and video-based lesson study). In addition, during meetings and in between meetings, teachers engaged in video clip viewing of one’s own instruction, and that of other teachers too (video-based reflective practice) and co-designing of
activities. The researchers conducted end-of-year interviews with teachers individually and gave regular surveys to teachers at the end of face-to-face meetings (on approaches to learning, practices and beliefs, and stages of concern to measure growth over time). It is important to mention that each face-to-face session began with a large group discussion about thoughts and experiences with strategies and practices.

The participants were University researchers, elementary cycle three teachers, secondary mathematics teachers, three educational consultants (elementary mathematics, secondary mathematics and technology) and the assistant director of educational services. There was variability in teachers over the years; however, a core number of teachers has remained constant. This core group became the focus of my research. This represented six teachers: three elementary and three secondary. As I elaborate on in the next section, my role in this project was to serve as one of the three educational consultants, namely the secondary mathematics one. The primary role of the consultants was to plan and facilitate all sessions with teachers. We also provided guidance and support outside the face-to-face meeting moments. We were an integral part of the leadership team with the university researchers and the assistant director of educational services.

1.5 My Professional Background and Premise

I worked as a secondary mathematics educational consultant within this PLC from 2013 to 2016. My role, as a consultant in this project, was one of collaborating with the University researchers to plan activities and sessions with pedagogical intent and sound research-based quality practices. I co-facilitated the sessions with teachers (e.g., face-to-face) along with the other educational consultants. As consultants, we led discussions, modeled best practices, introduced new approaches and strategies, and supported the teachers throughout the
collaboration and learning process. Outside of PLC meetings, we also exposed the teachers to research articles and mostly acted as coaches and mentors as they tried new strategies in their classrooms. The support we offered included personal meetings and classroom visits (with or without modeling). The consultants also led the discussions on the online communication platform in between sessions. We offered structure, a platform, and opportunities for teachers to reflect on their practice.

It was only after two years of involvement in the project (September, 2015) that I committed to the project as a thesis topic. This was the point in time that my dual role (consultant and researcher) began in the project, even though my primary role was still that of an educational consultant. It also coincided with the completion of my first year of graduate studies. Furthermore, during the 2016-2017 school year, my consulting role was put on hold because I accepted a school administration position. At such point, I continued my participation in the CCC-M project solely as a researcher.

As for my premise for choosing the CCC-M project as a thesis topic, well, this naturally came about while my graduate studies interests meshed with the underlying principles of the project. I refer here to my interest in Lave and Wenger’s (1991) communities of practice theory (CoP) as a theoretical lens. This interest began in the March 2015 when I wrote a synthesis paper that showed how involvement in a CoP led to learning, and thus change in teacher practices in the classroom. This was the point where the ideas from the CoP theory started to merge with my experiences from the CCC-M project and the qualitative data accumulated by the McGill researchers. However, what was really my driving force for studying this PLC?

To answer this question, I can assert the following. As an educational consultant, I have been involved in providing professional development (PD) to Anglophone teachers across the
province since 2007. I have designed and implemented multiple forms of PD ranging from short (one day or less) to medium (e.g., monthly meetings over a year) duration. I offered PD in small and large group formats, and sometimes to the same group over time. I even provided modelling, individual meetings and classroom support in between PD sessions. However, regardless of the format of the PD opportunity I offered to teachers, even with very positive feedback, it has rarely led, from my observations, to substantiated change in mindset (openness) towards new research-proven quality practices, and in turn, appropriation of these new practices and strategies. The CCC-M professional learning community was an exception. What was it about this PLC that accounted for its success in terms of dealing with the challenges of an educational reform in mathematics? What was it about this PLC that led to members changing their mindset about their participation in the project and readiness to embark on the pathway of new practices? For the purposes of this thesis, the CCC-M PLC will be treated as an illustrative case study that investigates how teachers changed their views about the purpose of the CCC-M PLC. Teachers’ views of the purpose of the PLC are revealing in terms of assessing the development of the community. A strong sense of community is key in addressing educational challenges and changes in teachers’ practices (Vescio, Ross & Adams, 2006; Stoll, Bolam, Mcahon, Wallace & Thomas, 2006). This query is especially important to me since I continue to work with PLCs as an administrator, with my team of educational consultants, trying to improve practices in our schools and centres. We face multiple challenges in getting authentic participation, maintaining participation and seeing improvements. The more we know about the evolution of PLCs the better we can support them.

I wish to also use my findings to improve PD with the ultimate aim of providing students with access and equity. In other words, I hope to provide them with “a high-quality mathematics
curriculum, effective teaching and learning, high expectations, and the support and resources needed to maximize their learning potential” (NCTM, 2014, p. 4), as it is reflected in the mathematics program documents of the Ministère de l’éducation du Québec.

1.6 Gap in literature

The existing research on professional learning communities focuses on the characteristics of PLCs and supports for their successful implementation (Little, 1999, 2001; Adajian, 1995; 1996; Vescio, Ross & Adams, 2006; Stoll, Bolam, Mcahon, Wallace & Thomas, 2006), but less about how they develop over time. This is another factor why exploring how PLCs evolve over time was a worthwhile investment. Whereas most of the literature describes the evolution of PLCs from researcher observations, this study shows the evolution of a PLC from a teacher perspective.

1.7 Research Overview

This research project aims to understand the development of community within the CCC-M PLC over the four years of the project. To attend to this objective, my research question was:

*How did teachers change their views about the purpose of the CCC-M PLC?*

I chose to conduct a holistic and illustrative case study using data collected by McGill researchers from interviews with the teachers from 2014 to 2017 (four year span of the project). I did not have a pre-set theoretical notion I wished to validate, nor did I abide to an experimental approach, since the data was pre-collected. I simply saw elements of the CoP theory through my participation in the project and as I worked my way through my methods and results. In my thesis, I used this theory to highlight how changes in teachers’ perspectives of the purpose of the PLC reflected the CCC-M project’s evolution as a community. The findings demonstrate a view, by teachers, that the project led to increased self-reflection about one’s own personal practice.
1.8 Chapter Summaries

This thesis is written in five chapters: introduction, theory, methodology, results and discussion & conclusion.

This first chapter, Introduction, situates myself as both an education consultant and researcher as well as providing the audience with the premise for my research. It also includes a brief background on professional learning communities and communities of practice as well as a summary of what is to come in other chapters.

The second chapter, Theory and Literature Review, provides the theoretical lens for my research and a literature review. Here, I introduce the communities of practice (CoP) theory by highlighting elements and characteristics that may explain the social learning and evolution happening with this PLC. I also provide a literature review on professional learning communities and other forms of collegial networks in the area of education.

The third chapter, Methodology, describes case study methodology and how it applies to my research. It also includes as a thorough description of my methods from interview responses to arrive at my results and observations.

The fourth chapter, Results, presents substantive evidence to illustrate the evolution of views from participants regarding the nature of the CCC-M project. It also provides data that connects features of the CCC-M projects to the communities of practice theory in order to illustrate learning.

The fifth chapter, Discussion and Conclusion, discusses my findings, presents contributions as well as elaborates on limitations and implications for further research. It ends with concluding remarks.
Chapter Two: Theory and Literature Review

In this chapter, I introduce the communities of practice (CoP) theory that I draw upon in my thesis. I highlight elements and characteristics of the theory that may explain the evolution of collaboration that occurred within the CCC-M professional learning community. I also provide a literature review on the topic of professional learning communities (PLCs).

2.1 The Communities of Practice Theory

2.1.1 Description and history of the theory. The theoretical lens of this thesis is based on a social theory of learning called the communities of practice (CoP) theory. Cognitive anthropologists Jean Lave and Etienne Wenger first developed this theory in 1991. A social theory of learning, according to Bandura (1963, 1971), is one which combines cognitive and behavioural learning theories and involves observation and imitation of others. It explains how new behaviours are acquired mainly due to the social engagement of participants, which in turn leads to cognitive development, and thus learning. Other social learning theorists include Albert Bandura and Julian B. Rotter. For the purpose of this thesis, I draw mostly upon the work of Wenger (1998) titled, *Communities of Practice*, to guide my analysis.

A CoP is defined as a group that evolves naturally over time because the members have common interests and goals. Through a process of sharing and engagement, the group members learn from each other and change their professional and personal identities (Lave & Wenger, 1991). This definition was further refined in recent years by Wenger-Trayner & Wenger-Trayner (2015) as “groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly” (p. 1). This definition suggests that a CoP is more than a group of people sharing a profession or craft, such as teaching. Instead CoPs must include
elements of purpose and membership. In addition, the authors elaborate on three key identifiers as being essential to a CoP; these are *domain, community* and *practice*.

A *domain* is representative of the commitment members have to the group (Wenger-Trayner & Wenger-Trayner, 2015, p. 2). More specifically, a domain refers to how members identify to a shared topic or focus by collective competence and commitment. In the case of the CCC-M PLC, the collective competence can be characterized as the teaching of mathematics and the commitment would be the boundaries of the project that members abided to.

Additionally, Wenger-Trayner and Wenger-Trayner (2015), describe a *community* as the cementing of members of the group through relationship building. Community is about the collaboration and the endeavors of the group in the pursuit of common interests. Here, participation does not have to happen daily or weekly but frequently enough for the collaboration to thrive and for learning to occur. In the case of the CCC-M PLC, this represents the collaborative activities that occurred in pursuit of the attainment of goals members had identified collectively. In other words, community involved the orchestration of meetings (frequency and type) by the leadership team in pursuit of building trust and addressing the challenges of an educational reform in mathematics.

Lastly, *practice*, according to Wenger-Trayner and Wenger-Trayner (2015), is about the doing, the sharing of expertise and the development of shared discourses amongst practitioners of a domain. I refer to the term discourses as language specific to a field. For example, discourses for mathematics teachers includes the use of expressions linked to problem solving (e.g., making conjectures). In the case of the CCC-M project, *practice* relates to the discussions members had about educational strategies and activities they were grappling with. When studying *practice*, one must consider the means through which members of the group
collectively develop their repertoire. This may include “experiences, stories, tools, ways of addressing recurring problems—in short a shared practice” (p. 2). As the authors note, the development of practice “takes time and sustained interaction” (p. 2).

2.1.2 The dimensions of practice. In his 1998 work, Wenger further describes what he means by practice and community, and the relation between these two concepts, by presenting three dimensions of practice that are the source of coherence of the community. These dimensions are mutual engagement, joint enterprise and shared repertoire (Wenger, 1998, p.73).

Mutual engagement can be seen as the act of getting participants to be productively and jointly involved. Mutual engagement is enhanced when members work frequently in close proximity. It is also a process which thrives on utilizing the members’ individual diversity to strengthen the CoP. Wenger (1998) provides an example of insurance claims processors, from very different backgrounds, brought together daily in the workplace to solve problems related to their job. These employees are mutually engaged by their frequent exchanges and routines. This engagement thrives on each person’s competence. In other words, diversity strengthens the overall competency of the group (p. 75).

Joint enterprise can be seen as the endeavor of the community. It is the goal of the members’ participation. In the example of claims processors, Wenger (1998) identifies money-making as an endeavor for this particular CoP (p. 78). Joint enterprise is enhanced when the CoP feels relevancy with the work that lies ahead or, in the case of the CCC-M project, the content of the PD. In other words, it should stem from a local need. For teachers in the CCC-M project, joint enterprise could represent the need to address the challenge of implementing effective student teamwork.
*Shared repertoire* can be seen as the discourses and resources used or built by the CoP over time. This can be represented by the group’s artifacts, gestures, styles, actions, etc. For example, such discourses could include the building of a common understanding of ambitious mathematics practice (e.g., how to provide feedback to students). Alternatively, shared repertoire could mean, during a face-to-face meeting in the CCC-M project, building a common discourse about using talk moves with students (e.g., repeat, re-state, etc.). It could also include an artifact, such as the co-creation of a mathematics lesson that addresses reform requirements. Wenger (1998) gives the example of medical terms taking on a specific usage for claims processors as they develop their repertoire (p. 82).

These three dimensions operate synergistically for members to negotiate meaning. Figure 1 illustrates these dimensions as well as corresponding descriptors (Wenger, 1998, p. 73).

*Figure 1.* The dimensions of practice. This figure describes the three dimensions along with their descriptors (adapted from Wenger, 1998).
These descriptors can be applied to the characteristics of the CCC-M project. For example, the descriptor *local response*, from the dimension *Joint Enterprise* could be represented, in the CCC-M project, as the PLC’s endeavors coming from a local response or a local need. As such, teachers became more invested. Together, they decided what lessons were worth creating or strategies were worth exploring (or trying) to answer a local need. I draw on these descriptors to understand the ways in which the participants of the CCC-M PLC described the purpose of the project over time.

### 2.1.3 Learning as a function of participation in a CoP.

According to Wenger (1998), social learning is a process that comprises *meaning, practice, community* and *identity*. These components of belonging are deeply intertwined as they work together for individuals to construct meaning of challenging ideas or, in other words, to learn. He presents these components and describes them as “learning as experience (meaning), learning as doing (practice), learning as belonging (community) and learning as becoming (identity)” (Wenger, 1998, p. 5). In the example of the CCC-M PLC, these components can be described as bringing our individual experiences to enrich the group’s collective competency (learning as experience), trying practices and strategies (learning as practice), participating in collaborative endeavors (learning as belonging), and changing our personal stories (identity) in the context of rich collegial experiences (learning as becoming).

I wish to emphasize that the characterizing elements of the CoP theory are not mutually exclusive. For example, the negotiation of *meaning* happens due to participation in a *community* where members are *mutually engaged* with each other. Moreover, *community* cannot happen in isolation from *practice*. The *practice* is what brought the *community* together in the first place.
For the case of the CCC-M PLC community, the practice of mathematics teaching was what brought the teachers together.

Furthermore, identity can be developed individually or collectively. Wenger (1998) illustrates how three modes of belonging interact together to form individual or collective changes in identity. These are engagement, imagination and alignment. Engagement is described as “the active involvement in mutual process of negotiation of meaning” (p. 173). In the context of a mathematics PLC, this could represent how teachers negotiate their understanding of implementing talk moves in a mathematics class. Wenger (1998) describes imagination as “creating images of the world and seeing connections through time and space by extrapolating from our own experience” (p. 173). In a mathematics PLC, this may represent how a teacher, based on personal experience, creates an image of how talk moves will be enacted in his/her classroom. Lastly, Wenger (1998) refers to alignment as “coordinating our energy and activities in order to fit within broader structures and contribute to broader enterprises” (p. 174). In the context of a PLC, this can be represented as teachers selecting a specific strategy (e.g., talk moves) for the purpose of a common lesson study. Here, teachers would all implement the same strategy and conduct individual as well as group reflection with the aim of improving the practice of this specific strategy, which is the broader enterprise.

To continue with my focus on learning as experience or the construction of meaning, I wish to explain how it occurs through the interlacing of two important processes, which Wenger (1998) identifies as participation and reification. Participation is a form of permanent engagement regardless of context, and reification is “giving form to our experience by producing objects that congeal this experience into ‘thingness’” (p.58). I believe these components are quite significant in the example of PLCs since it validates the need for teachers to sustain their
collaboration (participation) and produce things that represent their collective experience (e.g., activities or lessons).

Furthermore, learning is in part due to belonging to a community. This aspect, elaborated on in the previous section about dimensions of practice, played an important role in this study. Examples from the CCC-M project were used to exemplify joint enterprise, shared repertoire and mutual engagement and thus, to illustrate social learning.

In this thesis, given my focus on the development of community, I draw upon Wenger’s (1998) focus of learning as belonging to a community. To do so, I use the constructs of mutual engagement, shared repertoire and joint enterprise to understand how the CCC-M PLC evolved to develop an increased sense of community.

2.1.4 Differentiating a PLC from a CoP or another form of collegiality. Multiple terms are used in reference to collegial teams of teachers working towards common goals. I refer here to Professional Learning Communities (PLCs), networks, communities of practice (CoP), professional communities, and more. I will clarify a few of these terms especially those that relate to this thesis.

First, I wish to describe the term teacher networks, from the definition of Niesz (2007) who describes these as communities of practice with the aim of teacher learning and school improvement. She claims these networks follow a social constructivist model such as the communities of practice theory. I mention the term network since professional learning network was the expression used by the McGill research team in the initial description of the CCC-M project. Regardless if the CCC-M group of teachers is called a network of teachers or a PLC, at the very root of these names is the idea of professional inquiry to enhance student success. In this thesis, I most commonly use the term PLC since my focus is simply about a community of teachers “with the capacity to promote and sustain the learning of all professionals in the school
community with the collective purpose of enhancing student learning” (Bolam et al. 2005, p. 145).

Second, I wish to distinguish the term professional learning communities (PLCs) from communities of practice (CoPs) in relation to how I describe the community of teachers in the CCC-M project. Primarily, both PLCs and CoPs share a foundation of collaboration and are goal driven. However, a PLC, by its mandate (see Chapter One), can be more data driven through an action research approach or another form of inquiry. Furthermore, I used the CoP theory as a lens to analyze my data and to understand the evolution of the CCC-M PLC as a community. In summary, my goal is to use the teacher interviews to understand how changes in their descriptions of the purpose of the PLC reflected their development into a CoP.

2.2 Literature Review

My intent in this section is to provide a glimpse on the bulk of work done by various researchers in the area of Professional Learning Communities (PLCs), in terms of identifying characteristics of efficient PLCs and providing guidelines for the successful implementation and sustainability of them.

2.2.1 History of PLCs. Historically, professional learning communities are the result of a few educational movements that have emerged since the 1970s. Stoll, Bolam, McMahon, Wallace and Thomas (2006) discuss how the PLC concept developed from the notion of teachers acting like researchers in their classroom and playing a greater role in curriculum development. This was followed by a ‘reflective practitioner’ movement in the early 1980s which grew into a ‘problem solving school’ or ‘thinking school’ movement, which, in turn, became a ‘self-reviewing school’ movement (Stoll & al., 2006, p. 223). The term PLC started emerging from the work done by researchers such as Rosentholtz (1989) and Little and McLaughlin (1993).
They found that schools that were collectively committed to collaboration for the aim of enhancing student success, rather than working in isolation, showed improvements in teacher learning and greater gains in student success.

The notions of fostering a school community and of collective learning with the aim of improving school success became more evident as researchers studied teacher collaborations across schools (Little 1982, 1990; Driscoll 1987; Louis and Kruse 1995). From their work, researchers were able to differentiate between effective and supportive learning communities and groups whose meetings reinforced traditions and appeared contrived. The outcome of the research done identifies certain key characteristics of effective PLCs.

2.2.2 Characteristics of successful professional learning communities. Research on professional learning communities suggests several characteristics key to their success. Kruse, Louis, and Bryk (1995) and Newmann and Associates (1996) identified five “elements of practice” that are central to school professional community. These elements are shared norms and values (vision), a collective focus on student learning, collaboration, de-privatized practice (e.g., breaking the closed classroom door philosophy), and reflective dialogue (or inquiry). Stoll, Bolam, McMahon, Wallace and Thomas (2006), in their review of literature on Professional Learning Communities, specify the importance of considering the learning of the group as well as the individual. Additionally, their own research has confirmed other important identifiers of effective PLCs such as:

- mutual trust, respect and support among staff members; inclusive membership-
- the community extending beyond teachers and school leaders to support staff, and
- it being a school-wide community rather than consisting of smaller groups of
Among the characteristics listed above, the importance of self-reflection is re-iterated by multiple authors such as Bruner (1996), Ciment and Carrillo (2001), Jaworski (2003) and Scherer and Steinbring (2003) (as cited in Ticha & Hospesova, 2006, p. 133). They place reflection as an important step in the learning process. However, reflection as an intuitive act is not enough to bring about improvements in practice. It is the notion of conscious reflection that has the greatest influence on change (Ticha & Hospesova, 2006, p. 134). Consequently, certain structures need to be introduced during a PLC to allow for this kind of effective and conscious reflection. For example, some suggest that teachers use a post-lesson reflection journal with guiding questions.

Moreover, although teachers may develop content knowledge from individual reflection, it is the interactions with others, in the form of a community, which affects practice the most (Corwin, 1993). Similarly, Nilsson (2008), states that it is through genuine networking or social learning processes (e.g., collaboration, discourse, deliberation, production, etc.) that knowledge of teaching and conceptual ideas (e.g., mathematical concepts) are improved the most. For example, on the topic of joint reflection, in her study, Steinbring (2002) (as cited in Ticha & Hospesova, 2006, p. 133) found that this form of reflection required joint preparations of lessons and evaluation as well as making videotapes (recordings) of these lessons while they were being implemented. It was also recommended for teachers to attend each other’s mathematics lessons. The CCC-M project exemplified the latter requirements for joint reflection in its activities. Furthermore, Lewis, Perry and Murata (2006) suggest a lesson study model to improve
instruction. This model was greatly influenced by the Japanese lesson study model. Doig and Groves (2011) describe this process as:

Teachers with a common focus meet and plan lessons together. These lessons may have a focus on building skills or understanding, and are known as “research lessons”, which are taught by one, and observed by not only all of the teachers who are doing the planning, but also by observers who, at one end of the spectrum, may come only from the teachers’ own school, or, at the other end, may come from all over Japan. (p. 79)

Lewis, Perry and Murata’s (2006) lesson study model engages teachers in a cyclical process of first studying curriculum and formulating goals, followed by a planning phase, then conducting research and lastly reflecting on the lesson with the use of data. They argue that, via this process, teachers gain content knowledge, build a stronger sense of community with colleagues and create better resources for their students as well as for their own learning. Again, this model represents a process, which stresses the importance of conscious individual, as well as group, reflection.

2.2.3 Implementation and sustainability. The characteristics mentioned in the previous section are the result of effective implementation and sustainability of PLCs. The question remains: “How can we effectively implement and sustain PLCs?” Improved teacher collaboration requires positive leadership, varied forms of support, and specific structures (e.g., meeting time and format). A PLC cannot emerge simply from providing teachers with professional development opportunities. Educational leaders need to lay the groundwork for success. Principals or head teachers play a crucial role in the implementation and sustainability of PLCs. According to Stoll, Bolam, McMahon, Wallace and Thomas (2006), these school
leaders influence PLCs in their actions and views. Leaders do this in the way that they create a learning culture in the school, promote learning at all levels, model an inquiry vision and approach (e.g., action research or reflective practice), share the leadership and operate with emotional intelligence (i.e., being sensitive to fears about change and realizing that change is complex and takes time). Fullan (1993) emphasized that, “Conflict is essential to any successful change effort” (p.27). Additionally, Kotter (1996) and Fullan (1992) argued that the creation of school culture is essential in ensuring the success of the PLC.

Furthermore, leaders can also influence the success of the PLCs by managing structural resources such as time, space, interacting and drawing on external agents, support and partnerships (Stoll et al., 2006). Louis, Kruse, and Bryk (1995, as cited in Stoll et al., 2006) believe leaders need to ensure that teachers are given time to meet, work and reflect – either by being released from their classroom duties or by pre-determined blocked time in their schedules. For example, participation in a PLC cannot be seen as an added commitment (e.g., after school) to an already full schedule. There should be a considerable amount of time devoted to the PLC, especially in relation to the appropriation of a school reform. Moreover, collaboration seems to improve when members are in close proximity to each other. Therefore, the space should be carefully planned in order to facilitate formal and informal conversations and collaborations. Lastly, growth and sustainability has been observed in schools that have drawn on external agents (e.g., help from an outside leader on the subject of PLCs), support or partnerships. These supports could be district supports (e.g., school board support from educational consultants) and partner supports (e.g., partnership with University researchers), which is the case of the CCC-M project. It had both district and partnership support to assist in the implementation and sustainability.
On the other hand, research also highlights aspects that can impede implementation and sustainability. Dufour and Eaker (1998) elaborate on the difficulties of change and that the process is often enough not a smooth one. In their pursuit of supporting PLCs, Dufour and Eaker (1998) provide common mistakes in the Change Process (implementing change such as in the context of an educational reform) as described by Kotter (1996). These mistakes are:

- allowing too much complacency [...],
- failing to create a sufficiently powerful guiding coalition [...],
- underestimating the power of vision [...],
- undercommunicating the vision by a power of 10 [...], permitting structural and cultural obstacles to block the change process [...], failing to create short-term wins [...], declaring victory too soon [...] and neglecting to anchor changes firmly in the culture [...]. (as cited in Dufour & Eaker, 1998, p. 51)

These mistakes are more easily identifiable than they are to prevent or correct. Herein lies the challenge for educational leaders.

2.2.4 PLCs and the implementation of a mathematics reform. The teaching profession can be a challenging task given the realities of today’s classroom as well as the pressures to implement an educational reform and to be held accountable. However, the profession of ‘mathematics teacher’ brings additional challenges. The school reality is such that many mathematics teachers are either new at their trade, not trained for the subject or unprepared for change. In their study, Farooq and Shahzadi (2006) found that trained teachers in the subject of mathematics had a greater impact on student performance in comparison to untrained teachers. As such, it becomes imperative that school leaders must support all teachers in the area of ambitious mathematics practices, and PLCs may be this vehicle for change.
Recent research has shown the potential of PLCs for supporting teachers in implementing ambitious mathematics instruction. For example, in their work on supporting novice elementary mathematics teachers, Dalgarno and Colgan (2007) found that participation in professional community of practice, along with varied teacher professional development opportunities and technology facilitated learning, assisted novice teachers in gaining confidence and content knowledge as well as feeling less isolated. This was possible because participants had access to quality resources and shared personal teaching experiences with others either in a face-to-face format or via a forum for communication. Furthermore, the authors mention the use of a technology-facilitated community (i.e., online platform) to encourage communication amongst participants. These communications had a set weekly frequency and were facilitated by a team leader. This is valuable information in the context of the CCC-M project since it also used similar strategies, such as an online communication platform to encourage communication amongst participants between meetings and to assist instruction. The CCC-M leaders also launched prompts to the teachers to remind them to use the online platform to communicate and reflect.

Fulton and Britton (2011) conducted a study involving the synthesis of a large scope of research done on STEM (science, technology, engineering and mathematics) teachers engaged in PLCs. They were especially interested in examining teachers’ content knowledge, pedagogical content knowledge, instructional practices and their students’ achievement. The results of their study showed how teachers gained better knowledge of mathematics and science as subjects. Additionally, this study showed how teachers felt better prepared to teach those subjects.

Furthermore, in a publication from the National Council of Teachers of Mathematics, titled Stories of Excellence: Ten Case Studies from a Study of Exemplary Mathematics
Programs, Driscoll (1987) describes factors that were common to stories of excellence:

“effective leadership, careful decisions about the mathematics curriculum and its implementation, and classroom climates characterized by respect and dignity. However, the most important theme was the high cohesiveness, collegiality, and sharing among the mathematics staffs” (as cited in Adajian, 1996, p. 323). These claims justify the need for PLCs in the area of supporting teachers of mathematics.

2.3 Chapter Summary: The Gap in Literature and the Aim of this Study

In summary, the research suggests characteristics of successful PLCs as well as how their implementation and sustainability can be facilitated. However, there is a lack of research showing how PLCs evolve over time. Furthermore, more studies are needed in relation to the impact of PLCs. Vescio, Ross and Adams (2008) conclude their article by stating the need, in the area of educational research, for case, quantitative, qualitative and longitudinal studies that document changes in teacher practice as well as student achievement and learning. In addition, they specifically state the need for “quantitative studies that document changes in teachers’ perceptions of the professional culture of the school” (p. 90). The latter relates to my thesis since my aim is to show how teachers’ perceptions of the CCC-M project PLC evolved over time. Although I do not focus on the context of school culture, I provide analysis of change in the context of the PLC group itself. As I outlined earlier, I used the CoP theory as a lens to understand how these changes reflected the development of the community.
Chapter Three: Methodology

In this chapter, I will share my methodology and methods for my research. It is structured into five main parts and their sub-parts. The five main parts are: Case Study Research Methodology, Participants and Setting, Data Collection Methods, Analysis Methods, Presentation Methods and Validity of Research.

3.1 Case Study Research Methodology

The methodology I chose after careful reading and discussions with my supervisors is a case study (CSR). This is fitting since my research about how teachers changed their views about the purpose of the CCC-M PLC is a post event observation and reflection of the evolution of a group of mathematics teachers that worked collaboratively from 2014 to 2017. Studying the CCC-M project PLC as a case study has allowed me to understand the development of a community in depth. In addition, it was fitting giving the nature of the definition of CSR as an “empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between the phenomenon and context are not clearly evident (Yin, 2009, p. 18). The CCC-M project highlighted these characteristics of relative boundaries, contemporary setting and real-life context.

In this section, in order to validate my choice of case study research, I will discuss CSR’s history, including its key thinkers and philosophical underpinnings, then make a “case” for case study research and end with the characteristics of case study research. In other words, validating my choice of methodology for the CCC-M project PLC.

3.1.1 The history of case study research. The first case studies emerged in the early 1900s in the field of anthropology where participant observation was the main method of data collection (Johansson, 2003). At that point, there was a positivistic period after World War II
where social sciences methodology became highly criticized for not being “scientific” enough. To address this accusation, social sciences, by fear of not using acceptable methods, favored more quantitative methods. However, in the late 60s, a second generation of case study methodology emerged which mediated both positivism and hermeneutics as a philosophical foundation. A hermeneutic approach is an ever-evolving act of being engaged in the practice of interpretation. This means that this new way of case study research could be verified by empirical evidence and also value meaning. In other words, it placed more importance on understanding what is being studied rather than the adherence to a strict methodological agenda (Smith, 1999). According to Johansson (2003), this new case study methodology was in part due to the work of philosophers of science, such as Peter Winch and Georg Henrik von Wright.

The first of this second generation of case studies was grounded theory (Johansson, 2003, p.7). This methodology resulted from the work Glaser and Strauss (1967). Grounded theory is a research methodology that operates inductively. The type of generalization produced by grounded theory results from the data of the case study. It contrasts logico-deductive theorizing since it involves generating theories rather than verifying them (Glaser & Strauss, 1967, p. 9-15).

Johansson (2003) identified a third generation of case study research with the work of Robert Yin (1984; 1994). He described that Yin “transferred experimental logic into the field of naturalistic inquiry and combined it with qualitative methods.” (Yin, 1994 p.7) In other words, it combines qualitative and quantitative methods. Other such theorists include R. Stake, M. Q. Patton and B. Flyvbjerg. Their foundation is more eclectic and pragmatic in favor of methodologies from various paradigms. Patton stated, “A paradigm of choices rejects methodological orthodoxy in favour of methodological appropriateness as the primary criterion for judging methodological quality” (as cited in Johansson, 2003, p.7). This third generation of
case study researchers used methods that were more rigorous and explicit. This allowed their methods to be more accepted. I will be drawing from this generation.

Additionally, it can be noted that CSR does not use certain methods exclusively. A variety of other methodologies can be applied under its umbrella such as grounded theory, narrative inquiry, action research and ethnography (Duméz, 2015). In addition, CSR can be used to describe, understand and predict the behaviour and thoughts of individuals who are the subjects of the study (Woodside, 2017). In the case of my research, I am using it to understand the thoughts of teachers as they elaborate on the purpose of the project over the years.

3.1.2 Making a “case” for case study research. In this section, I elaborate on the reasons for using case study research methodology. First, given my involvement with the CCC-M PLC over the years, first as an educational consultant who was not driving the research, it is evident that I did not set-out initially to conduct an investigation with a pre-set theoretical notion (i.e. CoP theory) or methodology (i.e. case study research). Instead, I just saw the underlying principles in action over time. According to Gillham (2000), the notion of not beginning with an *a priori* theoretical lens is a fundamental characteristic of case study research since the lens should not drive the case, it should emerge from it, as in grounded theory. Although true in my research, this is not a universally accepted truth amongst researchers or of all case studies.

Second, I wish to recall characteristics of the definition of CSR by Yin (2009, 2014), mentioned at the beginning of this chapter, which refer to it as relating to contemporary phenomenon in a real world context with relative boundaries. The CCC-M project PLC officially existed from 2013 to 2017. Thus, my case is based on contemporary events. My research is an empirical inquiry since knowledge was gained through my observations and experience with the project over time. Additionally, my research has relative boundaries, meaning its procedures and
approach were not pre-set or fixed before data collection phase. In other words, my research question did not drive the activities of the project. The CCC-M project PLC evolved organically over time rather than abiding to a strict experimental design – there was no required control of behavioral events (Yin, 2009).

Simultaneously, Yin (2014) stresses the importance of the unit of analysis of the case study, the “who” or “what” of the case study from which the generalization will come, and defining the boundaries of the case. The unit, in this case, or the “who”, was the group of teachers involved in the high impact professional development endeavour, also known as the CCC-M project PLC. This unit is bound by studying the responses, or the “what”, during interviews of six key teachers over a four-year time span (2014-2017).

3.1.3 Characteristics of the case study. First, I will elaborate on the type of case study the CCC-M PLC project is. The CCC-M PLC case study, for the purposes of my research, was treated as an exploratory one. According to Yin (2003), this type is ideal for situations where the interventions have no clear outcomes. The interventions made by the consultants and researchers involved in the CCC-M project did not have specific aims in relation to social learning. The project evolved rather organically over time.

Second, I am treating this case as a holistic illustrative single-case study (Yin, 2009). By single, I mean that I studied only one PLC, the CCC-M project, and by illustrative, I mean that I will use it to familiarize my readers about how teachers changed their views about the purpose of the CCC-M PLC over time.

Third, I will elaborate on the purpose of my case study. My study of the CCC-M project PLC allowed me to make a generalization (Yin, 2009). I believe this case is so rich in information and so revelatory that it merits deeper analysis and generalization of findings.
Johansson (2003) states that “generalisations from cases are not statistical, they are analytical. They are based on reasoning. There are three principles of reasoning: deductive, inductive and abductive. Generalisations can be made from a case using one or a combination of these principles” (p. 8). Yin (2014) states that “the case study, like the experiment, does not represent a “sample”, and in doing case study research, your goal will be to expand and generalize theories (analytic generalization) and not extrapolate probabilities (statistical generalizations)” (p. 21). Considering these aspects, in this case study, my mode of generalization will be abductive since I will be “synthesizing a case from facts in the case and a principle (theory)” (p. 10). This equates to using qualitative and quantitative data and the CoP theory to build a case to illustrate how teachers viewed the purpose of the CCC-M project over time. As such, the generalizations will be to expand on the communities of practice theory. I wish to clarify that the principle (theory) was not pre-determined by the CCC-M leadership team (researchers and consultants) in the proceedings of the project. Rather, it was used in this thesis as lens for analyzing the data.

Fourth, I will elaborate on the categorization of the case study. Dumez (2015) suggests asking ourselves three basic questions before embarking in CSR: “What is my case a case of? What is the stuff that my case is made of? What does my case do?” (p. 48). These questions refer to, in order, the empirical and theoretical categorization, the type of case and the purpose (function) of its conclusions. To answer these questions, I could say that my case is that of the longitudinal development of community amongst elementary and secondary mathematics teachers. The stuff my case is made of is evidence, from interview responses, of participants’ views regarding the purpose of the PLC over the years as a way for me to understand the development of their community.
Fifth, I will elaborate on the empirical organization of my case study. My methods consisted of identifying classes of cases and sub-cases, which allowed the constant comparative approach to take form from the identified similarities and differences (Corbin & Strauss, 1990; Corbin & Strauss, 2014). The actual work of theoretical categorization did not appear until the end of this process (Dumez, 2015). This constant comparative approach was used to compare participant data from year to year. This will be further explained in my methods and observed in the results chapter of this thesis.

Lastly, the theoretical categorization should go hand-in-hand with my theoretical framework, which is Lave and Wenger’s (1991) CoP theory. According to the nature of CSR, the latter theory orientated my methods without strictly structuring it. In this case, the theory was only applied thereafter to assist in the analysis of the results.

In summary, I used a single-case study (i.e., the CCC-M PLC) as a longitudinal case (Yin, 2009, p. 53). I applied a constant comparative approach at four different points in time to illustrate the evolution of views about the purpose of the CCC-M PLC. To summarize my choices and how they connect to CSR, I present a table of information in Table 1, which follows.

<table>
<thead>
<tr>
<th>Table 1</th>
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<tbody>
<tr>
<td><strong>Summary of the Case Study Methodology for the CCC-M Project PLC</strong></td>
</tr>
<tr>
<td><strong>General Characteristics of the Case Study</strong></td>
</tr>
<tr>
<td>• Contemporary (2013-2017)</td>
</tr>
<tr>
<td>• Empirical inquiry</td>
</tr>
<tr>
<td>• Relative boundaries (organically evolved)</td>
</tr>
<tr>
<td>• No <em>a priori</em> theoretical notion</td>
</tr>
</tbody>
</table>
3.2 Participants and Setting

The CCC-M project was possible due to grants from two distinct granting agencies: one from the Social Sciences and Humanities Research Council of Canada (SSHRC) named a Partnership Development grant and the other from the Ministère de l’éducation du loisir et du sport of Quebec (currently known as the Ministère de l’éducation et de l’enseignement supérieur). The latter provided a programme grant named Chantier 7. The principal investigator of this project was Dr. Alain Breuleux. One research associate as well as a few graduate students regularly accompanied him to the research sites. Other researchers (from McGill and other universities) sometimes accompanied him, too.

The research took place at an English school board in Quebec. This school board is comprised of elementary and secondary schools situated across a large geographic territory, which serves residents of over 80 municipalities. Students come from various socio-economic backgrounds.

The participants in the CCC-M project included McGill researchers, elementary cycle three teachers, secondary mathematics teachers, three educational consultants (elementary mathematics, secondary mathematics and technology) as well as the assistant director of educational resources. The ratio of elementary to secondary teachers over the four years was as follows: 7:6, 5:5, 4:3 and 6:5. In year four of the project, four new members were added from the previous year. In this case, seasoned teachers were asked to invite a colleague from their school. Noticeably, there was variability in teachers over the years; however, a core number of teachers remained constant. This core group included three secondary teachers and three elementary teachers who were involved in the project for at least three of four years. I chose to focus my analysis on this core group because it would provide reliability to my data in establishing
whether there was consistency or change over time. Experience in teaching mathematics as a subject, for this core group, ranged from 4-19 years. Most elementary teachers described themselves as generalists while secondary teachers saw themselves as content specialists by either training or experience.

The project began in September 2013 and ended in June 2017. Table 2, presents a breakdown of the meetings and types of activities that occurred during each year of the project. Each school year, all participants were invited to attend four to five full day face-to-face meetings where the educational consultants would lead the discussions and activities, and the researchers would provide support at opportune moments. The structure and content of these face-to-face meetings, and other activities, were decided during planning meetings between the research and consultant teams. Each year objectives were maintained or introduced as well as activities, strategies or key themes.

<table>
<thead>
<tr>
<th>School Year</th>
<th>Objectives</th>
<th>Meetings</th>
<th>Activities, Strategies or Key Themes</th>
</tr>
</thead>
</table>
| 2013-2014  | • Foster a community of practice in mathematics teaching and digital tools  | Five face-to-face full day meetings | • Collective understanding of situation (in relation to reform)  
• Formative assessment  
• Peer observation via classroom visits (across levels) |
|            | • Develop collective understandings of the situation                      |          |                                                                                                                      |
|            | • Develop practice in terms of using digital tools for ourselves and for students |          |                                                                                                                      |
|            | • Sharing, reflection and inquiry                                         |          |                                                                                                                      |
| 2014-2015  | • Develop and test solutions based on collective understandings of the situation (design and implement video-based lesson studies) | Four face-to-face full day meetings | • Formative assessment  
• Math talk (discussion moves)  
• Reflection |

Table 2

Breakdown of Objectives, Meetings and Activities, Strategies or Key Themes by School Year
<table>
<thead>
<tr>
<th>2015-2016</th>
<th>2016-2017</th>
</tr>
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</table>
| - Develop practice of using digital tools for teaching and learning math and facilitate reflection and inquiry as well as sharing. *This will be explained in the next paragraph*  
- Continue the professional learning network in mathematics teaching and digital tools  
- Consolidate a long-term partnership between school board and McGill | - Peer observation via classroom visits (same levels)  
- Video based lesson study |
| - Cultivate a community of practice in mathematics teaching and digital tools  
- Develop solutions and measure and evaluate the results (more focus on student learning data)  
- Develop practice of using digital tools for teaching and learning mathematics  
- Promote reflective practice and inquiry  
- Consolidate a long-term partnership between school board and McGill | - Five face-to-face full day meetings and small group meetings during those full days |
| Five face-to-face full day meetings and small group meetings during those full days | - Four face-to-face full day meetings and two small group meetings (half day each) |
| - Student data (e.g., math notebooks)  
- Learning targets  
- Group work  
- Practices of high quality teaching  
- Video-based reflective practices | - Co-design of learning activities  
- Video capture of authentic classroom activities  
- Video-based collective reflection |

In year one, the leadership team focused mainly on activities that involved sharing and discussing ideas (e.g., mathematics reform, new strategies and practices or those already used by teachers). The leadership team additionally introduced new strategies and practices related to
technology (e.g., interactive white board math tools and the online communication platform to communicate amongst themselves and with students). Teachers were encouraged to use technology tools to ‘flip’ their classroom (i.e., reversing instruction by having students learn content knowledge outside of the classroom to focus on reinforcement activities during classroom time) and implement quality formative assessment practices. In this year, teachers also began flirting with the idea of learning from their peers by visiting each other’s classrooms.

In year two, the research team wished to introduce three new areas of study and development with teachers. These were lesson study, reflective practice and inquiry. Lesson study, as suggested by Lewis, Perry and Murata (2006), aimed to initiate a process of sharing lessons through classroom visits and video capture. For the production of video-based lesson study, the classroom activities were video-recorded and teachers engaged actively in the iterative process of lesson study: (a) identifying a lesson topic; (b) implementing the lesson; (c) sharing and discussing the video clip of the lesson with other teachers; and (d) re-designing the lesson. Reflective practice aimed to model and stimulate reflection: (a) to keep writing their own reflective journal; (b) to share parts of the reflections with other teachers on Edmodo (a global education online platform that helps connect learners to one another and to resources (Edmodo, 2018)); and (c) to play an active role in online reflective activities on Edmodo (e.g., posting questions and replying to other teachers’ messages). Inquiry aimed to model and stimulate inquiry. Teachers developed their competence in action research – a strategy to identify a problem in teaching and learning, implement change, and reflect and document their professional practice throughout the self-inquiry process. To facilitate the implementation of these aims, two lead teachers were assigned per area of development.
It is important to note that each face-to-face full day meeting began with a large group discussion around recent experiences with practices and strategies as well as general thoughts about the implementation of educational reform. It is during these moments of discussion and collaborative activities that social learning became visible. Teachers showed signs of a change in mindset toward more ambitious practices.

### 3.3 Data Collection Methods

A variety of data was collected by the McGill researchers, which included audio and video recordings of meetings, surveys of teachers’ beliefs and practices (e.g., technological, pedagogical, and content knowledge), video recordings of classroom visits, pictures of artifacts produced by teachers or students (e.g., math notebooks or co-created lesson plans), audio recordings of interviews with teachers, as well as teacher reflection questionnaires.

For this research study, I used the end-of-year individual interviews conducted by the lead researcher with each teacher participating in the project. My research is thus a secondary use of this data. The data originates from audio recordings as well as transcripts of these recordings. The principal researcher, conducting the interviews, used the same questions year after year as a means of establishing control in the data and allowing for a comparative approach in the analysis. Having the same interviewer also increased the reliability of results by reducing biases and inter-interviewer variability. The interviews lasted anywhere between 30 to 60 minutes.

The themes explored in the interview questions were about experience, expectations for the project, description of the project, usage of the online collaborative platform (i.e., Edmodo) as well as beliefs and practices in teaching mathematics. There were about ten questions asked to the participants, including questions such as: “What is your experience as a math teacher? Based on your experience in the CCC-M project, how could you describe the CCC-M project? How do
you understand mathematics as a subject?” Appendix A contains the full list of interview questions.

Although I used teacher responses from any question during the interview, the bulk of my data came from two of the early questions of the interview which stated: “Based on your experience in the CCC-M project, could you describe the CCC-M project? Or what are main features and characteristics?” These questions are important to my study since they provide insight on how teachers changed their views about the purpose of the CCC-M PLC.

The core group of six teachers were identified using letters (A, B, C, D, E and F) throughout my work as to respect confidentiality. This necessary process was crucial, not only for ethical reasons, but as a sign of respect for those I work closely with. Moreover, given my ongoing affiliation with the school board, I have chosen not to provide details of participants individually to reduce the likelihood of others in the school board community identifying a teacher. Teachers B, D and E were elementary teachers, mostly non-content (mathematics) specialists, with 7 to 15 years of teaching experience. These multi-disciplinary teachers taught mathematics for most of their career except for one teacher who was in her second year of teaching mathematics. Teachers A, C and F were secondary teachers with 5 to 19 years of teaching experience. One of these teachers was a university-trained content-specialist in mathematics. Furthermore, although students were part of the classroom visits and video recordings made by the research team, I am not using any data from child (student) participants in any form. I have deliberately excluded these from my research since they are not relevant to my investigation of the development of the teacher community.
3.4 Analysis Methods

3.4.1 Characterizing key ideas and hypothesizing a pattern. First, I listened to and read the transcripts of the interviews from each of the four years once, for each focal participant, while taking initial notes about expressions participants had regarding the purpose of the CCC-M project. These expressions were ideas such as “build bridges and share best practice” (Teacher B, 2014), “the opportunity to talk to other people […] and to try different things” (Teacher D, 2014) or “I see it as a sort of collaboration between three different levels of education […] And trying to find new and effective ways to present mathematics to students […] And then the sharing of all that stuff together (Teacher A, 2015). I then read the entire interviews again while taking additional notes about expressions.

Second, I proceeded to transform those expressions into simplified ones that I call key ideas, which characterized certain aims of the CCC-M project or elements of collaborative practice. For example, the expression “build bridges and share best practice” identified two key ideas: bridges (building them in the context of the CCC-M’s aim to address the transition between elementary and secondary school) and share (a collaborative practice). Other examples of key ideas from expressions included talk (about…), collaboration, trust, comfort, reflect, etc. My purpose for creating key ideas was to refine my methods to allow for a constant comparative approach of data across years and to better establish common ideas amongst participants. This facilitated the move from qualitative data to quantitative data as well.

Third, I compiled all the key ideas into a single document (with the year the idea was mentioned) and compared and contrasted key ideas across years for purposes of finding an initial, speculated, pattern. I found that key ideas in the early years were mostly expressions that referred to activities in the CCC-M project, or its purpose as a place to discuss, learn new
practices and strategies and bridge (or close) the gap between secondary and elementary school. Thus, I initially decided to refer to this early phase as the conversation phase of the evolution of the PLC. Subsequently, I found that teachers in the middle to late years, referred to the CCC-M project as a community or a place to exchange and collaborate. Multiple participants mentioned the idea of trust building within the group. Unlike discussing and trying things, collaboration represents a richer form of networking than discussing. By definition, to collaborate, according to the Merriam-Webster Dictionary (2018), is to “work jointly with others or together especially in an intellectual endeavor”. This is what happened in the CCC-M project as teachers co-created lessons, for example. As such, I initially decided to refer to this middle to late phase as the collaboration with trust phase of the evolution of the PLC. Additionally, I found that a few teachers in the later years, referred to the CCC-M project as an opportunity to collaborate that led them to reflect on their practice. Some teachers mentioned that they became more conscious of certain practices and behaviours, and that watching themselves on video has allowed this to happen. As such, I initially decided to refer to this late phase, not mentioned by all, as the self-reflection via community collaboration phase of the evolution of the PLC.

3.4.2 Coding transcripts for key ideas. I then proceeded to use the key ideas to code the transcripts. To do so, the key ideas were used as search words in the transcripts of each participant from 2014 to 2017. From the results, data tables were created for each participant inserting transcript sections, where key ideas were mentioned, into four columns: 2014, 2015, 2016 and 2017. These data tables include large sections of relevant parts of the interviews (i.e., turns of talk between Dr. Breuleux and the teacher participant). An example of such a data table can be found in Appendix B. Subsequently, I highlighted, using a different color per phase, the lines where the key ideas were mentioned: the conversation moments were identified green, the
Collaboration moments were identified aqua and the self-reflection ones were identified pink. I was careful to include additional turns of talk before and after those with key words mentioned in order to increase the validity of my data.

3.4.3 Validating the hypothesized pattern and identifying themes. In order to validate the hypothesized pattern, I tabulated (counted), in each participants’ data tables, the moments where key ideas were mentioned. Here, I was careful not to count an identical key idea multiple times in one turn of talk of the transcript, even though a key idea could appear multiple times, since this could skew the validity of my data. The tabulation is shown at the end of each column (by year) in each participants’ data table (see Appendix B). My hypothesized pattern proved to be correct. Therefore, I maintained the names given to each phase when I identified a speculated pattern: conversation, collaboration with trust, and self-reflection via community collaboration.

Lastly, to provide further validation of the pattern, the coded key ideas were compared and contrasted across the years. I was able to see themes related to multiple key ideas emerging from each phase of the evolution of the CCC-M project PLC. In the conversation phase, I identified themes such as novelty (new), gap closing and conversation. In the collaboration with trust phase, I identified themes of trust, collaboration, accountability and learning. I did not identify any themes in the self-reflection via community collaboration phase. I elaborate on these themes in Chapter 4.

3.5 Presentation Methods

I chose to first present the overall data in tables (see Chapter 4) which display the frequency of responses from participants by phase per year. These tables present the data in an aggregated format in order to respect the confidentiality of teachers. Then, those results were
displayed in a figure (see Chapter 4) in order to provide my audience with a better visual of the evolution of the CCC-M PLC.

To preserve confidentiality, as mentioned earlier, I chose to present my results as a single case study, the CCC-M group of six focus teachers as a whole, even though it would have been interesting to study the six cases individually to capture their unique trajectories and stories. It should be noted that two teachers did not provide results one year each of the project. One teacher was not a part of the project until the second year of the CCC-M and the other teacher could not attend the end of year interview in 2017.

3.6 Validity of the Research

3.6.1 Triangulation of data through external validity. Data triangulation increases the validity of results by “checking the integrity of the inferences one draws. It can involve the use of multiple data sources, multiple investigators, multiple theoretical perspectives, and/or multiple methods” (Schwandt, 2007, p. 298). In the case of this study, triangulation was done from the use of multiple investigators. The qualitative data used originated from data collected by the McGill research team led by Dr. Alain Breuleux, my thesis co-supervisor. Given Dr. Breuleux’s close affiliation with both the group of teachers (as part of the leadership team of the CCC-M project) and the data collected, he was able to authenticate my use of data.

3.6.2 Prolonged observation of a focus group. The constant comparative approach was applied across four years of data that I was closely connected to. This increased the accuracy of my research given the privilege I had in being engaged in both prolonged observation and participation in the CCC-M project. Another factor to consider would be my choice of selecting data from a focus group of six participating teachers rather than all the teachers that participated
in the project. I selected six teachers whose membership in the project was the most consistent
over the four years.

3.6.3 Peer reviewing. As I began identifying key ideas and noticing a pattern of
evolution, I immediately shared these findings with my co-supervisors Dr. Breuleux and Dr.
Kobiela as well as the research team. My initial findings became of use in their own work. This
additionally increased the credibility of my research.

3.6.4 Theoretical validity. According to Johnson (1997), theoretical validity occurs
when the data fits the theory. In this study, the qualitative data was studied under the lens of one
theory (i.e., CoP) and literature from multiple authors on the topic of professional learning
communities. The findings show close connectivity to both which allowed for a conclusion to be
“credible and defensible” (p. 286).

3.6.5 Clarification of research biases. Validity can be ensured by casting light on one’s
biases. My biases stemmed from my educational consultant role, my close relationship to the
teachers and my newly acquired educational leader role. According to Mehra (2002), it is
difficult as a researcher to separate herself from the process. To this, she said:

Qualitative research paradigm believes that researcher is an important part of the
process. The researcher can't separate himself or herself from the topic/people he
or she is studying, it is in the interaction between the researcher and researched
that the knowledge is created. So the researcher bias enters into the picture even if
the researcher tries to stay out of it. (p. 9)

The bias of my educational consultant role is one which influenced the topic of my study
as well as the motivation to arrive at results which demonstrate increased perception, on behalf
of teachers, of social learning. As a proponent of PLCs, even before engaging in this study, I had
great motivation for the findings to demonstrate that this type of rich collaboration leads to improvement in teacher practice and thus, student success. After years of experience in providing professional development (PD) to teachers, without deep impact, it became clear that long-term collaboration with specific aims was a preferred route to success. I had experienced a taste of this, before my work with the CCC-M project, from work with groups of mathematics teachers involved in data teams. Moreover, I had great motivation to show all stakeholders in the education community how strong an impact PLCs can have on school culture and teacher practice.

My close relationship to the teachers was another bias affecting how I may have treated the qualitative data. My relationship with the teachers varies from personal relationship, long-term colleague to mentor (coach). I have been building a trusting relationship with these teachers over the years and have provided multiple PD sessions to some of them. One of the teachers was my child’s classroom teacher during one year of participation in the CCC-M project. I can say that I was invested in seeing their professional growth and driving positive findings from this study as a means to maintain my credibility and authenticity as an educational consultant.

Lastly, as an educational leader (i.e. school administrator), I had great motivation to learn more about PLCs and to show their effectiveness to colleagues and staff. I have witnessed and participated in effective and ineffective PLCs. Having participated in PLCs, from an administrator’s perspective, has given me deeper insight on the challenges faced with their implementation and sustainability. Again, I had great motivation in this study’s effectiveness to assist me in my role of mentoring others with the ‘what to do and what not to do’. I brought with me previous conceptions, which I was hoping to bring forth with this study.
The methods of validity I describe above were important to helping me address these biases. Throughout, I was careful that the data I utilized, from the interview transcripts, represented teachers’ ideas honestly and equitably (e.g., no signs of bias in terms of favoritism). Moreover, I was careful to remain impartial. For example, the key word coding allowed me to objectively capture frequency of statements made in relation to key ideas.

3.7 Chapter Summary

The Methodology chapter provided an explanation of how case study research methodology was used to illustrate the evolution of views from teachers regarding the purpose of the project. In addition, it provided a description of the CCC-M project’s participants, setting and overview of the content by year. The chapter ended with an explanation of how my methods of using key ideas, originating from interview transcripts, allowed me to characterize phases of evolution. It concluded with an account of how I paid careful attention to validity during the entire research process.
Chapter Four: Results

My analysis of four years of interviews resulted in key ideas that were categorized under themes and three phases of the evolution of the CCC-M PLC. These phases are: (a) conversation; (b) collaboration with trust; and (c) self-reflection via community collaboration. Figure 2 provides a visual of the evolution of phases. The progression depicted is additive rather than distinct, meaning that elements of previous phases remain visible in later phases.

Figure 2. The evolution of phases of the CCC-M project PLC. This figure illustrates the additive progression of the social learning occurring across the four years of participation.

In the first part of this chapter, I will provide a description of each phase, drawing upon the qualitative data from the interviews. This will be followed by quantitative evidence of the evolution of the PLC. Lastly, I will connect data to the CoP theory to provide further evidence for its evolution.
4.1 Description of Each Phase

During my analysis I noted key ideas within the year(s) they were mentioned by teachers. These key ideas were color coded in the participant tables containing transcript sections. From this visual, a pattern emerged where certain key ideas were repeatedly mentioned in the early years of the project, whereas others emerged and were repeated frequently in subsequent years. As these key ideas were grouped, it became clearer that teachers viewed their participation in the CCC-M project PLC as an opportunity to talk, share, discuss and try new things. This evolved to a view that the project was an opportunity to collaborate more deeply with others. Moreover, a few mentioned the PLC was a vehicle that led to self-reflection about practice. This laid the ground for the three phases of the evolution of the CCC-M project PLC. In what follows, I describe the teachers’ ideas that characterized each of the three phases.

4.1.1 The conversation phase. Phase 1, about conversation, included key ideas under three themes: novelty (new), gap bridging and conversation. The first theme, novelty, included key ideas about discussions on the topic of new things (practices, ideas, etc.) and trying these new things. For example, in the first year of the project, a teacher expressed that the face-to-face meeting format provided an opportunity for spontaneous sharing by stating “… and to try different things. And, even just as soon as we arrive to our meeting, I find right away we are talking about ideas. Some of them were things we tried because we were asked by people in the project to try things, and other things were just spontaneous, and I think that the spontaneous sharing was very valuable…” (Teacher D, 2014). In the second year of the project other teachers shared their appreciation for ideas that arose from the face-to-face meetings, such as “new and effective ways to present mathematics to students” (Teacher A, 2015). On this topic, Teacher B stated: “I really appreciate the ideas that come about, and trying new ideas” (2015). Similarly,
Teacher E stated: “…it was a lot of bringing back what we learned into our classroom, and trying things out” (2015).

The second theme, gap bridging, included key ideas about gap and transition since many of the conversations involved exploring means to close the gap between elementary and secondary teachers or involved discussions of the elementary to secondary transition period for students. These statements were reflective of the aims of the CCC-M project. For example, Teacher A stated an appreciation for addressing this transition issue by saying: “I like the idea of its [CCC-M project’s] transition between, you know elementary and high school” (2014). Additionally, Teacher C clearly expressed personal interest in addressing transition challenges for students by stating: “Ya the bridging the gap between grade 6 and 7, I really want to see” (2014). Lastly, another teacher reflected about the collaborative nature of the project and its aim to connect teachers: “I think the main features are collaboration and building bridges and share best practices” (Teacher B, 2014).

The third theme, conversation, included key ideas about discussing (talking) with colleagues in the PLC. For example, Teacher D, displaying an appreciation to connect with others, stated: “I think the most valuable part of this year has been the opportunity to talk to other people” (2014). Teacher F more specifically noted an appreciation to connect between different groups of teachers: “Well, I like the fact that the conversation between elementary and high school happens” (2014). The importance of discussion was not immediately evident to teachers. For example, Teacher A reflected that he/she had not considered the importance of discussion at the onset of the project: “It would be the discussions and sharing experiences, um, I do actually, even though I didn’t know” (2014). Table 3 provides a summary of the conversation phase.
<table>
<thead>
<tr>
<th>Themes</th>
<th>Key Ideas</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Novelty (new)</td>
<td>• New ideas</td>
<td>“I really appreciate the ideas that come about, and trying new ideas” (Teacher B, 2015)</td>
</tr>
<tr>
<td></td>
<td>• New things</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• New ways</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Learn new (things, …)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Try (as in things, practices, strategies, …)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Share (new strategies or practices) to elaborate that it is a superficial level…</td>
<td></td>
</tr>
</tbody>
</table>
| Gap bridging     | • Gap (bridging or closing the gap between the transition from elementary to secondary) | “I like the idea of its transition between, you know elementary and high school” (Teacher A, 2014).  
*Here, “its” refers to the CCC-M project* |
|                  | • Bridges (building them)                                                 |                                                                                                                                         |
|                  | • Transition (as in from elementary to secondary)                         |                                                                                                                                         |
| Conversation     | • Discussion                                                              | “I think the most valuable part of this year has been the opportunity to talk to other people” (Teacher D, 2014)                          |
|                  | • Conversation                                                            |                                                                                                                                         |
|                  | • Talk (about new…)                                                      |                                                                                                                                         |

**4.1.2 The Collaboration with trust phase.** Phase 2, about collaboration with trust, included key ideas under four themes: trust, collaboration, accountability and learning. These key ideas reflected a sense of building a community and more profoundly, a community of practice (CoP) founded on trust, which in turn led to learning. Some teachers’ statements reflected views that comfort was a sign of trust being built. For example, Teacher F stated:
I think now that people are starting to get more and more comfortable with one another, they’re a lot less reticent to get out there and sort of expose yourself in a teaching environment and be comfortable with people coming back and talking to you about what they saw, without feeling judged (2015).

Similarly, Teacher E stated: “But as I started to learn and become more comfortable too, with the community of teachers and what not, that we had working together, I found it easier to work it into…” (2015). Additionally, there were signs amongst participants that comfort within a community can open the communication channels to what could be described as peers who are friendly critics. To this idea, Teacher A stated: “Community people are comfortable to share and ask questions and sort of get a good idea what, of what their peers think or and they are open to, to, not criticism but” (2016). Lastly, Teacher B, not only stated feelings of comfort within the community, but how this had led to increased comfort with math as a subject. This teacher said: “And now I feel comfortable, and this is just helping me feel more comfortable with math” (2015). Trust and comfort are signs of respect, which is a sign of an effective PLC.

The second theme explored in this phase is that of collaboration. A few teachers mentioned the idea of collaboration explicitly when describing the project. For example, Teacher A stated: “I see it as a sort of collaboration between three different levels of education” (2015). Others used descriptors of effective PLCs, for example: “I do really appreciate when we see our colleagues at those face-to-face meetings. Um, I really enjoyed having a common goal together so that you could talk to someone about it” (Teacher B, 2016). Here, the teacher referred to the idea of shared values and vision (i.e., common goal). Noticeably too, from teacher responses, was the sharing aspect of the project. Teacher A mentioned: “But I do think people have used

1 This statement ended there and the conversation continued with the interviewer
resources, shared resources quite a bit and I do think as a community” (2016). Furthermore, teachers who genuinely engage in collaboration mutually support each other. In relation to this idea, Teacher E described: “Yeah! I really do feel like we’re supporting each other and helping each other out” (Teacher E, 2017).

The third theme explored in this phase is accountability. This important characteristic of effective PLCs is also referred to, by certain authors (Williams & Hierk, 2015; Stoll et al., 2006), as collective responsibility or reciprocal accountability. For example, in reference to the homework given to participants between face-to-face meetings, which encouraged teachers to try strategies or practices and stay connected to others for feedback and support (via the online platform Edmodo), Teacher B stated: “This makes you kind a little more accountable” (2015). Another teacher, in relation to the tasks assigned in the CCC-M PLC, described the following: “I think the only thing that works is that peer pressure. You know? Like [chuckle] and I say that using that word but I think that’s the only thing that would work for me is to feel like, accountability” (Teacher D, 2016).

The fourth theme explored in this phase is learning. Participants mentioned how participation in the project led to learning, or in terms of the CoP theory, constructing meaning. For example, Teacher D articulated how meaning was constructed from social engagement: “Together, I think we have constructed almost a new understanding” (2016). Another teacher (Teacher E) highlighted how the experience led to individual efficacy. Teacher E exclaimed: “I think I have learned more in this project that I have in a lot of other professional development sessions or you know workshops that I have been to, so…” (2016). This evidence substantiates previous claims that PLCs are effective means of building sustainable teacher capacity. In relation to the Wenger’s CoP theory, the statements made by teachers provide insight on how
meaning was constructed through participation and reification. Table 4 provides a summary of the collaboration with trust phase.

<table>
<thead>
<tr>
<th>Themes</th>
<th>Key Ideas</th>
<th>Examples</th>
</tr>
</thead>
</table>
| Trust           | • Constructive criticism  
• Trust  
• Comfort  
• Safety  
• Confidence (becoming more)  
• No judgement | “I think now that people are starting to get more and more comfortable with one another, they’re a lot less reticent to get out there and sort of expose yourself in a teaching environment and be comfortable with people coming back and talking to you about what they saw, without feeling judged” (Teacher F, 2015) |
| Collaboration   | • Help each other  
• Ideas from inside the group  
• Find solutions (as a group)  
• Connection  
• Exchange (*more collaborative than share*)  
• Community (sense of)  
• Together  
• Common goal  
• Network  
• Getting together (to collaborate not just try new things)  
• With like-minded people  
• Support  
• Work together, not against each other  
• Planning together  
• Infectious growth-contagious (ideas expanding to other colleagues in the school) | “I do really appreciate when we see our colleagues at those face to face meetings. Um, I really enjoyed having a common goal together so that you could talk to someone about it” (Teacher B, 2016) |
| Accountability  | • Accountability  
• Peer pressure (to be accountable) | “I think the only thing that works is that peer pressure. You know? Like [chuckle] and I say that using that word but I think that’s the only thing that would work for me is to feel like, accountability” (Teacher D, 2016) |
Learning from and off each other
Led to increase learning-Best PD (professional development)
Mindset change thanks to network
Constructing new understanding together

“Together, I think we have constructed almost a new understanding” (Teacher D, 2016)

“I think I have learned more in this project that I have in a lot of other professional development sessions or you know workshops that I have been to, so…” (Teacher E, 2016)

4.1.3 The self-reflection via community collaboration phase. Phase 3, focused on *self-reflection via community collaboration*, includes key ideas about how participation in the CCC-M PLC led to self-reflection about practice. In this case, any reference to going back and thinking about things (e.g., strategies, practices) was considered a key idea. Here, teachers stated that they learned from viewing themselves in the classroom video captures. They claimed they became more mindful and self-conscious. In reference to video capture, Teacher A said: “It is interesting though to go back and re-watch what I actually say to the students, right? Because then you are like: ‘Oh! That actually wasn’t very clear’ so have the opportunity to replay the audio…” (2016). Similarly, teacher F explained: “Yeah, I’m a little more conscious of what I say and how I explain stuff” (2017). Additionally, Teacher C self-reflected and gained insight on how students learn: “… you get to actually go back and reflect and then see how you and what you did kind of impacted the kids” (2016). Moreover, this teacher added: “Also, filming you were able to reflect on yourself a lot easier” (2015). The reflection process helped one teacher realize some ideas were worth future consideration: “But it’s something I am going to reflect on this summer” (Teacher E, 2017). Lastly, Teacher C explicitly stated, early in the project, that a focus in that particular year was about self-reflection, showing an awareness of this goal: “This year it was really more about teacher reflection, looking at what you could do differently” (2015). Table 5 provides a summary of the self-reflection via community collaboration phase.
Table 5

The Self-Reflection via Community Collaboration Phase (social learning)

<table>
<thead>
<tr>
<th>Themes</th>
<th>Key Ideas</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Reflect</td>
<td>“This year it was really more about teacher reflection, looking at what you could do differently” (Teacher C, 2015)</td>
</tr>
<tr>
<td></td>
<td>• Going back</td>
<td>“Yeah, I’m a little more conscious of what I say and how I explain stuff” (Teacher F, 2017) in response to the use of video and reflection activities and discussions.</td>
</tr>
<tr>
<td></td>
<td>• Become aware of one’s…</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Rewatch (in a mindful manner)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Learn a lot by watching</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Think about</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• More conscious about (self)</td>
<td></td>
</tr>
</tbody>
</table>

4.2 Evidence of the Evolution of the PLC

In this section, I will first provide an overview of the quantitative data, which shows the trends of the evolution of the PLC. This will be followed by theoretical evidence linking the data to the CoP theory.

4.2.1 Quantitative evidence. Tables 6 and 7 as well as Figure 3 represent the aggregated data of the frequency of statements relative to each phase (conversation, collaboration and self-reflection) the teachers made by year (2014 to 2017). Phase 1, about conversation, is represented in blue. Phase 2, about collaboration with trust, is represented in orange. And, phase 3, about self-reflection via community collaboration, is represented in grey.
Table 6
The Frequency of Statements Relative to Each Phase

<table>
<thead>
<tr>
<th>Year</th>
<th>Phase 1 Conversation</th>
<th>Phase 2 Collaboration with trust</th>
<th>Phase 3 Self-reflection via community collaboration</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>18</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>2015</td>
<td>12</td>
<td>17</td>
<td>2</td>
</tr>
<tr>
<td>2016</td>
<td>6</td>
<td>32</td>
<td>6</td>
</tr>
<tr>
<td>2017</td>
<td>6</td>
<td>32</td>
<td>11</td>
</tr>
</tbody>
</table>

Table 7
The Frequency of Statements, as a Percentage, Relative to Each Phase

<table>
<thead>
<tr>
<th>Year</th>
<th>Phase 1 (%) Conversation</th>
<th>Phase 2 (%) Collaboration with trust</th>
<th>Phase 3 (%) Self-reflection via community collaboration</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>90</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>2015</td>
<td>39</td>
<td>55</td>
<td>6</td>
</tr>
<tr>
<td>2016</td>
<td>14</td>
<td>72</td>
<td>14</td>
</tr>
<tr>
<td>2017</td>
<td>12</td>
<td>66</td>
<td>22</td>
</tr>
</tbody>
</table>

Figure 3. Frequency of Statements Relative to Each Phase by Year. This figure shows the evolution of the CCC-M project PLC, by phase.
The results show a clear decrease in the view, expressed by teachers, of the project being mostly about themes such as novelty (trying new things), gap bridging (addressing the transition from elementary to secondary school) and discussing pedagogical approaches (e.g., strategies). The chart shows a decrease of 78% in frequency of responses for the conversation phase from 2014 to 2017. Still, responses aligned with these themes continued to emerge and rightly so. Teachers were continuously engaged in dealing with new ideas, strategies and alerted to the fact that the aim of the CCC-M project included addressing the transition from elementary to secondary school.

Simultaneously, it is visible that teachers expressed more frequently over the years that the nature of the CCC-M project was about collaboration. This view increased in frequency of responses from 10% to 72% over the span of the project, with a slight drop to 66% in 2017. Although with the years teachers stated that the purpose of the CCC-M project was also about self-reflection on one’s own practice, this view did not replace the main view of the project being about collaboration. Collaboration remained the strongest purpose of the project.

In addition, the efforts of the research and consultant team, with respect to promoting self-reflection practice, led to fruition. Starting in 2015, a steady increase in frequency of responses can be visualized from 6% to a final frequency of 22%. The data, in this thesis, is presented in an aggregated format to respect the teachers’ confidentiality. However, when analyzing the frequency of responses by individual teacher, over the years, it was observed that some teachers did not mention self-reflection as a characteristic or purpose of the project. This will be discussed further in the final chapter.

4.3.1 Analysis of findings in connection to the CoP theory. I wish to first support my claim that conversation about practice is a lower form of engagement in a PLC, or CoP, than
collaboration. According to the Merriam-Webster dictionary (2018), to collaborate is to work jointly with others or together especially in an intellectual endeavor. Wikipedia (2018) defines collaboration as the process of two or more people or organizations working together to complete a task or achieve a goal. Collaboration is similar to cooperation. Most collaboration requires leadership, although the form of leadership can be social within a decentralized and egalitarian group. The latter, defines nicely the nature of the CCC-M PLC or CoP. In the early phase of the project, teachers talked about strategies and practices. They would go off and try a few. This was followed by continued discussions in later meetings. However, it is not until the later years that teachers met with the aim of achieving a goal set for themselves or towards a common endeavor.

This movement towards a common goal connects directly to my theoretical lens of a community being an entity that is negotiating meaning through participating in the project. Collaboration in the form of a community, according to Wenger (1998), is not something we can turn on and off. Rather, it becomes part of who the participants are. He claims that participation “goes beyond direct engagement in specific activities with specific people. It places the negotiation of meaning in the context of our forms of memberships in various communities. It is a constituent of our identities” (p. 57). For example, one teacher mentioned how her engagement in the CCC-M impacted another form of membership in her school community as well as her identity as a math teacher. This teacher, since she gained confidence in her math teaching abilities due to her participation in the CCC-M project, had created infectious growth in her school:

I like that we're able to all try and bounce ideas off each other (referring to CCC-M PLC). It just makes me want even more for people to try it in my own school.

But, you know what? The more I get excited and talk to them about the fact that,
"oh yeah, we all tried it, and we all did it, and this is what the experience was,"
they're starting to want to try things too. Or, at least, asking me to do it with their
class. So, it is starting to spread. (Teacher B, 2017)

When collaborating in a CoP, according to Wenger (1998), participants are mutually engaged, have joint enterprises and share a repertoire of actions, discourses, tools, etc. rather than simply discussing practices and strategies. This type of social engagement leads to learning, and for some, deeper learning as well as appropriation of high quality practices due to increased self-reflection. These concepts relate to the self-reflection via community collaboration phase. Although Wenger (1998) does not identify self-reflection as a higher level of social learning, he explains that the combination of engagement and imagination results in a reflective practice. As such, we learn by being engaged in imagination processes, which allow us to step outside ourselves, fantasize and gain other perspectives. Engagement, through participation in different kinds of activities (e.g., video clip viewing), permits imagination to take place or “be negotiated in practice and realized into identities of participation” (p. 217). In other words, it leads to learning and appropriation, in this case, of teaching practices and strategies. It should be noted that this research thesis does not aim to assess the level of appropriation of high quality practices. It simply aims to highlight the teachers’ views of the purpose and results of their participation in the CCC-M PLC, characterize the views, grounded in connections to the CoP theory. Table 8 provides further insight on how the CCC-M project exemplified the CoP theory by highlighting connections to the Dimensions of Practice, introduced in Chapter 2.
<table>
<thead>
<tr>
<th>Dimensions of Practice</th>
<th>Descriptors</th>
<th>Clarifications and examples from the CCC-M project</th>
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</table>
| Joint enterprise        | Negotiated enterprise | - Teachers may have had different views about the reform and practices but they were engaged together in trying to make sense of it.  
- They found a way to solve problems together or to make sense of challenging ideas.  
- They had different interpretations at times. However, they often came to a common understanding.  
- Members of the community (CCC-M PLC) were mutually accountable to each other and to various functions in the community (e.g., implementing lessons and providing feedback to the group thereafter).  
- The PLC had its own rhythm when it came to the implementation of joint enterprises. It would first verbally hash it out, then collaborate on strategies to make it successful in the classroom, implement the practice or lesson and then reflect as a group on how it went and how it could be improved.  
- Their endeavors came from a local response or local need. As such, teachers became more invested.  
- Together, they decided what lessons were worth creating or strategies were worth exploring (or trying) to answer a local need. |
| Shared repertoire        | Stories  
Styles  
Artifacts  
Tools  
Historical events  
Concepts  
Discourses  
Actions | - Each member of the CCC-M PLC had his/her own story, discourse and style that they brought to the group. This, in turn, made it a richer community.  
- They shared ideas, practices, tools and strategies. They also shared classroom events whether these were successful or unsuccessful.  
- In their actions, as members of a community, they built a shared repertoire to answer the needs of the reform or simply to improve their practice. |
| Mutual engagement        | Engaged diversity  
Doing things together  
Relationships | - The community was not about homogeneity. It thrived on the uniqueness of its members. Each person’s story and competence was a building |
Social complexity
Community
Maintenance

block for the growing mutual competence of the group.

- The CCC-M group thrived on its social diversity. Rarely before had elementary and secondary mathematics teachers, at this school board, joined for so long and for such a purpose. Each member brought a different perspective and experience to the table.
- There were norms of participation and mutually agreed terms of accountability. These were presented and monitored by leadership team (researchers and consultants). For example, one of these means was to communicate via the online platform (i.e., Edmodo).
- The leadership team orchestrated events to help build relationships (e.g., trust) and maintain participation.
- Mutual engagement is not simply about being in the same school or same room. It is not just about being a passive member during a professional development session. It is more than that. It is about being invested in a greater purpose (i.e. dealing with the challenges of a reform).
- A community was built due to the frequency and quality of meetings and activities members were engaged in.
- A community was built also due to the duration of the CCC-M project.

Lastly, on the topic of negotiated enterprise (from joint enterprise), I wish to highlight the transition from internal to external drive. Earlier on in the project, the leadership team planned the face-to-face meeting, orchestrated discussions about sharing practices and strategies, proposed pedagogical approaches and strategies, engaged teachers in specific pre-planned activities, presented research on quality practices, and more. However, once teachers identified goals and student learning issues, it became clearer that teachers were becoming self-driven. They, as a community, found direction and purpose for their participation and actually engaged
in productions or joint enterprises. They would also decide together which practices or strategies to explore. For example, one teacher stated in one of the later years of the project: “I like that a lot of the, a lot of our ideas are coming this year, I find came from within the group, instead of coming from outside the group” (Teacher F, 2016). It should be noted that artifacts collected by the researchers also supported the claim of ideas being externally driven in the early years of CCC-M and internally driven in the later years. For example, the meeting agendas (inserted in power points of face-to-face meetings) show that the activities, strategies and practices were suggested by the leadership team in the early years of the project. Later, the meeting agendas indicated teachers working collaboratively on developing and implementing lessons, with designated practices, that they had selected for themselves. The lessons produced by teachers, are also examples of artifacts collected.

4.3 Chapter Summary

The Results chapter provided evidence that shows how teachers in the CCC-M project viewed the purpose of the project over time. The evidence showed an evolution of views across three additive phases of development: (a) conversation; (b) collaboration with trust; and (c) self-reflection via community collaboration. These phases emerged from an analysis of key ideas from the teacher interview transcripts from 2014 to 2017. This chapter followed with the aim of connecting the evidence of rich collaboration to the characteristics of the communities of practice theory, to provide evidence the group’s social learning as a community. I focused these connections on the dimensions of practice by Wenger (1998): joint enterprise, shared repertoire and mutual engagement.
5.1 Discussion of Results

The aim of this study was to illustrate how teachers changed their views about the purpose of the CCC-M PLC. The findings revealed that across four years of engagement in the project, teachers’ views evolved from considering the PLC as being conversationally focused to collaboratively focused and based on trust. Some, especially in the later years of participation, considered the PLC as a vehicle for self-reflection on practice. Additionally, with respect to illustrating the evolution, this study provided characteristic themes for each phase derived from the actual words of teachers (during interviews). The themes, shown in Figure 4, assisted in defining the phase and casting light on the effectiveness of the PLC. Teachers stated how conversation, trust building, accountability and rich collaboration were significant features of the project as well as having a defined vision (aim), exemplified by the theme named gap bridging.

Figure 4. The key themes of each phase of the evolution of the CCC-M project PLC. This figure illustrates the additive progression of phases and teacher identified key themes.
Teachers made direct statements regarding their learning. Some stated how they had learned more in this project than any other professional development they participated in. Furthermore, qualitative data revealed that meaning was constructed from their social engagement in a process that Wenger (1998) refers to as the weaving of participation and reification.

This study aimed to connect teachers’ learning, as stated from teachers and not observed directly from classroom practice, to participation in a community of practice (CoP). The CCC-M PLC, developed into a CoP since it was comprised of members “who share(d) a concern, a set of problems, or a passion about a topic, and who deepened their knowledge and expertise in this area by interacting on an ongoing basis” (Wenger, McDermott, & Snyder, 2002, p. 4). Here members strengthened their practice, community and domain from mutual engagement opportunities, joint enterprises they engaged in, and from developing a shared repertoire (Wenger, 1998; Wenger-Trayner & Wenger-Trayner, 2015). Links were made between each dimension of practice (i.e., mutual engagement, joint enterprise and shared repertoire) and the activities or framework of the CCC-M project PLC. Results showed how focusing on these dimensions of practice in turn strengthened the CoP.

A constant comparative approach was used to analyze qualitative data across a four-year timespan. This yielded a pattern that showed that teachers viewed the CCC-M project PLC as a being primarily about collaboration with a growing view that it involved self-reflection too.

The findings raise important points for further discussion in this chapter, such as the importance of building trust, varying support measures, creating opportunities and tools for effective reflection, seeking outside partnerships. In what follows, I explore these points, as well as limitations, implications for further research, recommendations and concluding remarks.
5.2 Contributions

5.2.1 The importance of building trust. The qualitative data from interview transcripts revealed a high frequency of responses related to trust being built in the community of teachers. This frequency became apparent at the June 2015 interviews, after two years of participation in the project. Key themes such as constructive criticism, trust, comfort, safety, confidence and no judgement emerged across the span of the project showing an importance and appreciation for this characteristic of the PLC. This finding furthers similar findings in other studies. For example, in their study of a professional development project between a community of elementary teachers and university mathematics educators, Sztajn, Hackenberg, White and Allexsaht-Snider (2007), revealed three characteristics identified by teachers as helping build trust in the community after one year of participation: “professionalism of the mathematics educators, the organization of the project, and the establishment of school-university relations” (p. 983). Their study also revealed the importance of caring relations, especially in relation to the mathematics educators vis-à-vis the teachers. This relates to the CCC-M PLC in the types of activities organized by the leadership team, the meeting norms negotiated by all, and the caring relationships amongst all members of the PLC. Activities based on rich discussion and collaboration, as well as group reflection may account for the trust being built. The data of the CCC-M project PLC revealed significant mention of trust after two years of participation, providing proof that building successful PLCs is a long process but worthwhile one. This finding related to the time required to build trust (i.e. two years) extends the literature on PLCs. However, the time here should be presented in terms duration and frequency of collaboration rather than simply years of collaboration, given the evident variability each year could represent.
The CCC-M project PLC aided in breaking the ‘closed classroom door’ culture since teachers were now, more than ever, “working together, not against each other” (Teacher D, 2016).

5.2.2 Varying support measures. Interview responses from teachers indicated a shift in support measures. Teachers stated how in the later years of the project, ideas came from within the network rather than from an external source (e.g., the leadership team). Although support is critical to the success of a PLC, it becomes essential at some point to help the PLC members develop autonomy. Stoll et al. (2006) mentioned the importance of helping schools to develop this capacity over time in order to improve sustainability. Additionally, they stated how “external agents may play a significant role in supporting schools’ enquiry efforts and helping develop a school’s ‘reflective intelligence’” (p. 241). This does not disregard the importance of help from external agents to build competency and consequently, confidence. For example, in their literature review, Dalgarno and Colgan (2006) state the importance of building content knowledge, pedagogical knowledge and pedagogical content knowledge through external supports. Support measures of the CCC-M project from the leadership team (e.g., educational consultants) provided this for teachers during whole-group sessions, small group sessions and individual support moments (e.g., class time support, one on one meetings and classroom modeling). Lastly, the observation of shift from outside to inside the community extends the literature on mathematics PLCs by providing specificity on how this shift looks like. That is, the literature alludes to the building of autonomy but does not refer to an observed shift.

5.2.3 Creating opportunities and tools for effective reflection. Reflection was found to be a contributor of growth experienced by CCC-M project PLC. Tisha and Hopesova (2006) in their study about reflection to improve mathematics education, identified several kinds of shifts and benefits due to reflection (self and group). They especially stressed the importance of joint
(group) reflection. The CCC-M project leadership team provided opportunities for both self and joint reflection. This was facilitated by practices such as video-based lesson studies and video-based collective reflection. Here, teachers were given questionnaires to self-reflect on their lessons. Additionally, teachers were provided with guiding questions to reflect on videos that captured moments in other teachers’ classrooms. Face-to-face joint discussions occurred during meeting times. The reflection practices that took place were deliberate, not simply intuitive.

Another strategy put in place by the leadership team was to introduce an online platform (Edmodo) to assist teachers in supporting each other as well as joint reflection. Unfortunately, the leadership team experienced difficulties maintaining teacher motivation, either from lack of support measures (e.g., time) or a failure in building collective responsibility with respect to this form of reflection. However, the use of social media to enhance joint reflection could be worth exploring in future research.

5.2.4 Seeking outside partnerships. Although it was important for the teachers to develop independence, the CCC-M PLC’s affiliation to an outside partnership with University researchers and school board educational consultants played an important role in moving towards independence. Stoll et al. (2006) identified partnerships and external supports as key contributors leading to the success of PLCs. They assist in the implementation of the PLC, building teacher capacity as well as helping schools develop autonomy. Consequently, this facilitates the sustainability of the PLC. Sztajn, Hackenberg, White and Allexsaht-Snider (2007) found that establishing school-university relations was a key factor in improving mathematics instruction. The partnerships in the CCC-M project helped build content knowledge, pedagogical knowledge and pedagogical content knowledge through the endeavors that highlight joint enterprise, shared repertoire and mutual engagement (Wenger, 1998). Moreover, the partnerships provided
structure for other key characteristics, associated to successful PLCs, to be enacted (e.g., identification of student learning problems to develop a PLC shared vision and mission, norms to enhance collective responsibility, collaborative activities, etc.). In closing, Fullan (1993) claims that seeking help is a sign of a school’s vitality. Future work at our school board will be to encourage schools to seek outside partnerships.

5.3 Limitations

This study had limitations in terms of assessing the level of appropriation of ambitious practices and the application of these in the classroom. It used researchers’ observations of teachers’ perceptions of learning instead of evidence of learning from their classroom practice. Evidence of learning could have been studied by analyzing video capture of teachers in their classroom, analyzing artifacts collected from classroom activities and delving into student success data. However, this was not the purpose of this study.

Another limitation of the study was individuals’ orientation to change (Stoll et al., 2006). The participating teachers were volunteers for the project. For the most part, these teachers had participated greatly in other professional development opportunities before the CCC-M project. Therefore, the study did not assess the views of resistant teachers towards PLCs. Moreover, in the focus group of my study, one teacher had been an educational consultant for one year, another a school administrator and another was simultaneously completing graduate studies (Masters). Regardless of motivation, the project consisted of mathematics content specialists, seasoned teachers, novice teachers and generalists. Overall, many of the participants were already displaying signs of collegiality but not necessary confidence in teaching mathematics.

Another limiting factor could be that the CCC-M PLC meetings occurred outside of the teachers’ schools. The school context and culture may have influenced the PLC differently since
learning is affected by the context in which it takes place (Stoll, 1999). Being in the school may have led to a stronger sense of belonging and impacted a school more greatly however, the effect could have been reversed. Teachers in the PLC may not have experienced such a profound sense of community collaboration in a more adverse school culture.

Furthermore, the study could have assessed the difference in views from novice teachers and more experienced teachers, and likewise from content-trained specialist teachers and more generalist type teachers. It could have also compared the views of elementary teachers to secondary ones. All these analyses would have yielded interesting differences in trajectories. In relation to the latter, I wish to mention that the study did yield differences in individual trajectories to those of the group as a whole (for example, in relation to the growth of their reflectiveness). This was not explored in this thesis since it could have increased the likelihood of identifying a teacher. However, it should be noted individual trajectories showed changes in teacher identity, efficacy and beliefs as mathematics as a subject to teach and learn. These beliefs arose from responses to specific interview questions during the same interview June interviews as this study. These questions were: “How do you understand mathematics as a subject? What do you think the students should learn from math class? How do you describe your teaching and role in the math class?” (Appendix A)

5.4 Implications for Further Research

Research on professional learning communities can benefit multiple stakeholders such as school board level administration, educational consultants, school administration, teachers and students. Based on the limitations I outlined above, I believe the next steps would be to focus on direct observation of changes in teacher practice (i.e., concrete signs of learning or appropriation of ambitious mathematics practices). In addition, as Vescio, Ross and Adams (2008) mention in
their concluding thoughts, there is a need for studies that focus on student achievement too. They suggest:

- in depth case studies of changes in teaching practice and student achievement for sample teachers working in PLCs, qualitative documentation of the nature of the work teachers do as they analyze student work and how this changes over time, in depth case studies of changes in student learning for sample students in classrooms of teachers working in PLCs, quantitative documentation of changes in student achievement over time as teachers engage in work in PLCs. (p. 90)

Moreover, further research in the area of reflective practices occurring in PLCs would be beneficial to stakeholders. I believe that there is still a lot to learn about self-reflection and joint reflection. This would require researchers to delve into tools that assist in effective reflection practices and observe results on both the appropriation of ambitious mathematics practices and the effects on student performance.

Qualitative data from the CCC-M project or other PLCs, could additionally be used to track changes in identity and beliefs in mathematic as a subject to teach and learn. Studying how collaboration in a PLC can lead to fundamental changes in the way teachers perceive themselves as math teachers and the way they teach, could have been a worthwhile investigation.

Lastly, as an educational leader, I would like to examine additional research in the area of creating a culture of trust (building trusting relationships), especially in more difficult school contexts. It would be of value to conduct case studies of effective leadership in these contexts. I give importance to this element since ‘trust’ was frequently mentioned by participants in the CCC-M project. Dufour and Eaker (1998) and Dufour, Dufour and Eaker (2008) provide insight relative to effective leadership but a greater number of concrete examples would be helpful.
5.5 Recommendations

I wish share some of my favorite interview statements from teachers in an attempt to convince school leaders to invest in professional learning communities. I present three words of advice.

My biggest advice is to be patient. Changing teaching practice is a complex process and it takes time. Teacher F said: “that’s the frustrating part. And I think everybody falls into that. But, one thing about teaching is, it’s hard to break a routine. It really is hard to break a routine” (2017). Teacher E understood that “things take time, (chuckle), that’s the only thing that stands out” (2016). In the last year of the project, Teacher B went on to support the previous claim by stating: “I was happy that we weren't learning anything new, but really trying to solidify what we did. And yeah, and that it just takes time. I think that really... I really learned that lesson. It takes time. I saw it. I saw it happen” (2017).

My second piece of advice is for PLCs to take the time to build trusting relationships. As seen in my results, through trusting relationships, teachers will improve their collaboration and thus, learn. Communities grow stronger when provided with opportunities to build mutual engagement, develop a shared repertoire and work on joint enterprises (Wenger, 1998). Teacher D believed that, “Together, I think we have constructed almost a new understanding” (2016), which exemplifies the negotiation of meaning described by the CoP theory.

My third piece of advice is to seek external support for assistance in implementation, building teacher capacity and helping sustainability. Outside partnerships, with educational consultants and university researchers provided the CCC-M project teachers with varied supports (e.g., modeling of practices in the classroom, a structure for reflection and keeping the focus on identified aims). Regarding acquired ambitious practices in teaching mathematics as a subject,
Teacher B stated the following: “but now that there is all these different ways, I am understanding and I am feeling confident. … now it’s fun, it’s creative and I never thought it was creative” (2016).

5.6 Conclusion

In summary, the CCC-M project PLC became a vehicle for change in grappling with the challenges of an educational reform in mathematics. The careful planning of a leadership committee allowed a community of practice to build through participation in activities that highlighted joint enterprise, mutual engagement and shared repertoire. This community of mathematics teachers strengthened over four years of participation. In time, elementary and secondary teachers changed their views about the purpose of their participation in the project. They viewed their early participation as being conversationally based. This view evolved to the project being about collaboration with an emphasis on the trust that was being built amongst members. Additionally, in the later years, most teachers realized how their engagement in the project led them to be more self-reflective about their practice.

To conclude, I am forever grateful to have participated in this rich endeavor and furthermore to have selected the CCC-M project as my thesis topic. This adventure has been the most enriching professional development opportunity I have had as both a mathematics educational consultant and educational leader (administrator). The CCC-M project has “made math more than math” (Teacher B, 2016)!
References


Appendix A

Interview Questions for CCC-M Teachers (June 2014 to 2017)

General questions:

1. What is your teaching experience as a math teacher?
2. How did you get involved in this project?
3. What were your major expectations when you participated in this project?
4. Based on your experience in the CCC-M project, how could you describe the CCC-M project? Or what are main features and characteristics?
   - What activities do you like during the first year of the project? Why?
   - What do you think you’ve learned from this project (any ideas, strategies or technologies)?
   - What would you like to apply to your class in the future?
5. What do you expect for this project in the coming school year? (topics; activities; technologies)
   - What are your thoughts/opinions on these kinds of activity? (e.g., lesson study, reflective journal, lead teacher, video recording)

Edmodo use:

1. In what way have you used the Edmodo?
   - If an active user, what do you like about using the Edmodo? Any challenges, if any?
   - if an inactive user, what did hinder you from using the Edmodo?
2. Any suggestions to facilitate the teachers' uses of the Edmodo (or any other platforms)?
Beliefs and Practice in Math

1. Questions related to the teacher's responses to the survey.
   - How do you understand mathematics as a subject?
   - What do you think the students should learn from math class?
   - How do you describe your teaching and role in the math class?

2. What do you find challenging about teaching math?

3. What kind of support do you need to improve your math teaching?
Appendix B

Example of Data Table: Teacher B

<table>
<thead>
<tr>
<th></th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. AB:</td>
<td>Based on your experience in the CCC-M project, what do you think are the main features of the CCC-M project?</td>
<td></td>
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</tr>
<tr>
<td>TEACHER B:</td>
<td>I think the main features are collaboration (1) and building bridges and share best practices (1).</td>
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<tr>
<td>5. AB:</td>
<td>What activities did you like during the first year of the project? Why?</td>
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<tr>
<td>TEACHER B:</td>
<td>I really enjoyed the activities that entailed creating lessons together and teaming up with H.S teachers both for activities and classroom observation (2).</td>
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</tr>
<tr>
<td>6. AB:</td>
<td>What do you think you’ve learned from this project (e.g., any ideas, strategies or technologies)?</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>TEACHER B:</td>
<td>My favorite strategies shared were to incorporate more</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>5. AB:</td>
<td>So the first question is, globally, how would you describe the CCCM project? A project that you’ve been involved in last year and this year. So I’m interested in your perspective on it, your perception. What do you see as the main features or characteristics of this project?</td>
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<tr>
<td>6. TEACHER B:</td>
<td>So after the couple of years we’ve been doing it, I see it very much as, first of all, really understanding what we cover in math, cycle three, how it relates to what they do it in high school. It’s nice to see what is actually happening at the high school level, what is the same, what’s different. It helps me to understand more what I need to focus on. So that’s been a really good thing. Also I really appreciate the ideas that come about, and trying the new ideas</td>
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<tr>
<td>1. A:</td>
<td>….CCCM main features…?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. TEACHER B:</td>
<td>um i find this year, there was a lot, not that there was a lot more to apply in a classroom but a lot more methods of teaching (1). Whereas, i felt the previous year there was a lot of ideas to add to the teaching.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. A:</td>
<td>hmm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. TEACHER B:</td>
<td>whereas this time there was really methods of teaching. When we looked at the group work, how to really do proper group work, um that was one instance that really stands out for me, so there was more of a, not just little ideas but really to kind of change how you teach completely (2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. A:</td>
<td>hmm ok</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. TEACHER B:</td>
<td>not, maybe, maybe that</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. AB:</td>
<td>Okay, so today is May eighth. We're at BLANK with BLANK, for the end of year interview. So, BLANK, it's more or less the same questions as usual, but the point is to see how your views might have changed, evolved, and so on. So the first broad questions are about CCCM in your words, in your own perception of it, what are the main features of the project?</td>
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</table>
| 3. TEACHER B: | Okay. What do I think… Okay. One of the main features is really trying to see how children tackle problems, and how we can make it easier for them to understand word problems, to work in teams and to use each other productively, to listen and to get them to talk more. How can we bring them to a... Talk more about math in a way that's productive, not just, how do you I say it?
completion, quick ways to reach students with difficulties more efficiently, and the sharing of technology ideas which lend themselves well for centers (3).

1. AB: How do you understand mathematics as a subject?

TEACHER B: Math has never been my strong suit, or so I believed, but being involved in this project as well as other math centered projects, I have come to realize that I am actually on the right track.

2. AB: What do you think the students should learn from math classes?

TEACHER B: I believe students should learn basic math facts, how to apply logic and solve problems.

3. AB: How do you describe your teaching and role in the math class?

TEACHER B: I think, after a while, even when you've been teaching a while, you start to use the same ideas. It's nice to get a refresher, and it's nice to get a refresher that you're kind of forced to try right away.

7. AB: Okay.

8. TEACHER B: And then come back on it. Because often, we do go to workshops, but then you're like, "oh one day I'll do this." And you don't. This makes you kind of accountable for trying it, and coming back and being able to share. It makes it more active, active improvement. Like a personal professional development that's actually put into place, and built upon.

9. AB: So the fact that it's closer, the ideas are closer to being implementable?

10. TEACHER B: Exactly.

11. A: hmm

12. TEACHER B: you know, to how can they learn math better? How can we teach it so that they can learn it better?

13. A: hmm

14. TEACHER B: and really look at math as not this…, um like that's what i find has changed for me, math is not just this thing where we open a book, and it's just numbers and that's it. Math has become a discussion, math has become an activity, math has become just as discussion provoking Not just saying things to say them. Like, "I can't calculate it." But to really understand what they're doing. So it becomes more of a way of thinking, and a way of going about solving problems, instead of just trying to look at the numbers. So I see that and I see working together as teachers, to try new things, and all try the same things, so that we can really see what are the strong points, what are the things that we have difficulties with. So that, I find, is something that's very important. And also that connection and knowledge of what is...what are they doing in the other grades, in high school? That's very... So those would be the three things. I know that in the past we've done a bit more technology. I think we've kind of taken a little pause there a bit, but that's okay because we have a lot to try, and a lot to kind of test over and over again type thing.

4. AB: Yeah. So, the last thing you
**Teacher B:** The role of the teacher should be to model, provide practice, and create a stimulating and helpful learning environment.

4. **AB:** What do you find challenging about teaching math?

**Teacher B:** I find it difficult to keep the students who have facilities in math stimulated and still learning while trying to help the students who are experiencing difficulties.

5. **AB:** What kind of support do you need to improve your math teaching?

**MV:** As mentioned before, I think an activity kit that would perhaps revolve around technology, self-correcting, and practice work that could be done independently while others need extra time. Perhaps this resource would include some advanced work that students who want to be challenged could find interesting. I would love to have the time to create the

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<th>Question</th>
<th>Response</th>
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<tr>
<td>151. <strong>AB:</strong> Okay. Okay. The other questions have to do with your conception of mathematics as a subject. So, how do you see math as a subject?</td>
<td><strong>Teacher B:</strong> Well, like I said, it as a science class could be or a language arts class could be, so that’s something. I see the project has made math more than math.</td>
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<tr>
<td>152. <strong>Teacher B:</strong> [whispers] if that makes sense.</td>
<td><strong>A:</strong> ... PLN...?</td>
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<td>153. <strong>A:</strong> Okay. Okay.</td>
<td><strong>Teacher B:</strong> I think it's really amazing, because you often... Even though I work in a big school and there's lots of teachers, teachers tend to like to do their own thing, their own way, because, right, you're trying to manage so many students at once. So it's not that you're not open to other peoples' ideas, but sometimes you're just doing what works for you, because that's the way you can manage and handle your day. So I like that. You know, sometimes you're excited about an idea, and you want to try it, and you might tell a colleague. And even though they think it's a great idea, it's a bit scary to try it. I like having a network of teachers that I know are trying the same...</td>
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was never my favourite. I find it very difficult. But I find what I like is that I can relate to what the problems are, because I'm one of those kids who gets the problem in front of them, and my brain goes into this freeze, and I don't know what to do, and I panic. So I understand that. Or, the understanding of what numbers are. Like, what is a million? I don't know. What is a million? It's just a number with six zeros, I don't... You know what I mean? So I really understand that they don't understand. So I find that me going through this is helpful for me, for the methods, to teach better. And I find, you have to be comfortable with math. You have to be comfortable with numbers. And understand what you're talking about. You can't just teach from the text book, which I think is what often is the misconception. If you don't like math, it's okay, you just have to begin beginning of the project.

21. A: hmm hmm

22. TEACHER B: You know and so they are hard to, it's hard to convince, or just give it a try, they are not as open. Whereas, i like the network of teachers, because we are trying and we are making mistakes but we are not worried about falling behind (4), because the kids are still learning a different way, they are solidifying something else, you know?

41. A: so you said that you are likely to be the math specialist, it's something that surprises you but you seem to

42. TEACHER B: yes

43. A: you said you like it

44. TEACHER B: yes i do

45. A: how does that happen?

things as me, and maybe making mistakes, and maybe not getting to the right answer. (2) But I like that we're able to all try and bounce ideas off each other.(2) It just makes me want even more for people to try it in my own school. But you know what? The more I get excited and talk to them about the fact that, "oh yeah, we all tried it, and we all did it, and this is what the experience was," they're starting to want to try things too. Or at least asking me to do it with their class. So it is starting to spread. (3)

9. TEACHER B: Expectations... It's hard to say, because this year we tried something different in our regular program. We're doing this bridge program. It's the first year that I'm teaching math, only math, which already is a shock to my own system. I can't believe that actually is happening. So I think my expectations were just to try everything I learned, and to find
follow the text book. That's not true.

155. AB: No, no. You're right.

156. TEACHER B: So now I feel I work a math a lot, a lot, for my whole career. And now I feel comfortable, and this is just helping me feel more comfortable with math (3). And being able to, on the spot, make connections. Like, "hey this is math that we're talking about." In real life situations. Not just the obvious ones, but just things that happen all the time. Or, to be able to come up with an alternative way of doing something. And I've found that I could only do the things before that were in the book. Now I've been able to come up with another alternative just on my own. Because my brain understands. So I find, seeing that happening, that's what I want to happen to my students. So it happening to me makes it more, actually I know it's possible. So I have

46. TEACHER B: i think because i was, i think those walls that we kind of broke down, with either you are good in math or you are not good in math and the whole manipulatives, because i was taught the traditional way, and now all of the sudden when we are working out things and talking about things and giving time to become comfortable with terms (5), because there are a lot of terms, and i think as a, when i was learning there was just never any time, so i just kind of grasped on to anything, and any trick i could and now as a teacher, i was just following what the plan said, you know, following the teacher’s guide, just doing, [inhales] but now that there is all these different ways i am understanding and i am feeling confident (6)

52. TEACHER B: now it’s fun, it’s creative, and i never thought it was creative

that confidence. And the reason why I'm doing math is because of what we did learn, and what we learned as a group, and what we were able to share, because I have these people to support me, (4) and the ideas, that I was just hoping that I would make it through this year and feel like a competent math teacher. (5) Because I was a little bit nervous. And just, I don't think I would have been able to do this year, if I didn't have the CCCM to kind of fall back on for support, for professional development, for team work, for collaboration. All that stuff is what I felt. I felt supported in this new project, that was my own personal project. (6) So that's why I think I can't even go any further with what I expected in the project itself. The project helped me get to expectations that I had to have for myself here, (7) as a teacher. Yeah.

10. AB: What did you like among the
more hope, instead of just get the answer right.

157. AB: So how do students learn that?

158. TEACHER B: I think from practice, from talking about it, from trying different things, from making mistakes, from seeing me make mistakes and fixing them, and practice. Practice, practice, practice. Like anything. I try to tell them that too, it's like a sport, right? You just have to practice.

159. AB: Mhm.

160. TEACHER B: And find different ways to make it work for you. So variety, but obviously not too much variety at once.

161. AB: So as a teacher, teaching math involves presenting kids with a lot of opportunities to practice.

162. TEACHER B: Yes.

163. AB: Encouraging them to explore different

55. A: …..mostly this year or built gradually over the 3 years?

56. TEACHER B: probably gradually because of those little tools and ideas like; edge of creation or the different ways to do application problems, or, it gave me something to work with because all i was doing was teaching the problem, and, and then if they had a question or it went a wrong way i was kind of [uuuh] speechless, i didn’t know what else to do with it, now i feel like there is all these creative ways and ideas that i can tap into so i felt comfortable because i felt like i had a bank of ideas and a bank of things that i could try and also discuss with others and hearing that others are having successes but failures as well (1)

62. TEACHER B: as when i teach it, she is just teaching it a different way so we have a couple of kids, who are like: “aah!” but i am seeing that constant: “oh my god activities that we had this year?

11. TEACHER B: I really like creating new lesson plans that we all try. I really like that. And I like to see how things turned out, or how they tried it. Like the Krispy Kreme was fun. The same thing as last year, we kind of had done the same kind of thing. I like that. I like when we build a problem and really decide how we're going to teach it, because I feel I come back and I have a couple of weeks of planning already done, and I'm excited because I want to see what's going to happen. It's almost like an experiment.

14. AB: Exploration. Do you think you've learned something, anything this year? What might that be?

15. TEACHER B: Just this year?

16. AB: Yeah.

17. TEACHER B: This year. But it takes a while. I learned this year that it takes
ways of looking at a problem.

164. TEACHER B: Yes. Being grouped up with people who are like them, too, so that it's not intimidating. Because right away I find, with math, because there's a right and wrong answer, you tend not to want to answer if you're not right, because it's wrong. Right? Whereas maybe in something like English or history, you're bound to get something right. It's your opinion. It's a story. You know? You remember something. If you don't understand the math, you don't understand it. And you're more... It's harder to take risks, because you're going to be wrong.

165. AB: But do you want kids to be able to take risks?

166. TEACHER B: Yes. I want them to take risks. So I think it's important to not always be with someone who's really great at math. I think it's really important what's wrong with me as a teacher. What's wrong?” it's now not there, and i am just able to work on things individually, because i was really feeling bad

63. A: ya

64. TEACHER B: so her coming into the classroom more, modeling, and then me trying her things but then also seeing that her results were the same and she has even come in for the exams and seeing like, i feel backed up

70. TEACHER B: just a lot of support, with something i was uncomfortable with, and now i have become comfortable with it, because of all that support (7).

82. TEACHER B: ya, that i, it’s the manipulatives, i, i was, because in grade 6 we don’t usually use those manipulatives anymore and really show concrete examples [inhales], bringing those in was a whole new revelation for me as a many years to get where we are, I guess. This year, I'm really starting to see it fall into place, in that I'm not so overwhelmed with everything we're learning. I'm just excited to figure out how to fit it all in. So this year I felt like I was happy that we weren't learning anything new, but really trying to solidify what we did. And yeah, and that it just takes time. I think that really... I really learned that lesson. It takes time. I saw it. I saw it happen.

63. TEACHER B: No. To watch. Not just the video. Live, to me, is so different. Because you see everything happening. And then I actually would be watching the teaching strategies, because sometimes you see how they're reacting to... So from a different point of view, I find I learn a lot by watching and observing , (1) not just the children. Right? Because in the end we want the children to improve,
for them to be with kids who are at their level in math. I'm really starting to see that. Whereas before, it used to be, "go with someone who can help you."

167. AB: Yeah. I think there's value to both. But you probably need to mix experiences with similar...

168. TEACHER B: Similar understandings. Yes, I see it's good to mix, but it's just that I didn't see it before. I always did mix, so I thought everyone's strengths would come in. But now I'm seeing why maybe that's not always... Because I'm seeing these kind of questions, or the different techniques we're doing. You kind of need to be thinking the same way, in a way.

169. AB: So the notion that when math are clear cut answers, you don't have opinions, opinions don't matter. But on the other hand we explored math talk this year, which teacher, um for it to see what's out there, it made me wanna to just scope out and look for more and also when I tackle a problem now, I find I tackle it not just using, like cross multiplication, I tackle it saying: "How would I represent this?"

83. A: ok

84. TEACHER B: and it takes me a little longer and I am doing things like go at recess it's just like a little: "who wants to find a little math problem at recess?" so it's made me enthusiastic and I noticed that the kids are a little more enthusiastic about it too.

203. A: questions about math as subject?

204. TEACHER B: math as a subject. I mean it's about how the world works around us, kind of, like how math is all around and I think to teach it as that, not just as a page in a textbook, where it's adding to see. Math is but also somehow I'm responsible for that too, right? You can't just say, "they'll just learn." [Laughs] So I like to see what other peoples' tricks are, and how they might use manipulatives and stuff, because that was something new to me too. To cycle three, using manipulatives isn't very practiced. It was Tina Moradi who really brought that in, and that ended up being amazing. So now I have like tons of manipulatives, and they use them. So that would be something I'd love to kind of explore a little more.

102. AB: Um, viewing clips from other teachers' classrooms, do you see a benefit to...?

103. TEACHER B: I see a benefit, for sure. I often just feel like, "are my kids doing the same thing?" Or, "are they discussing the same?" I see where that would be the benefit too, for me, to see on video whether everyone's talking. I'm still... When I watch the
takes a different look at mathematics as a/ 170. TEACHER B: Which makes math a little more easier for the language learner. That's what I like. That's where it made it better. 171. AB: So how do you see that math talk component of teaching? It's easier for the more... 172. TEACHER B: Well, the mathematical mind enjoys talking about math, so that gives them the opportunity to talk. Whereas usually they can't. They don't really care about synonyms, and stuff like this. It's not interesting to them, or interesting vocabulary. So now they're talking more, and participating more because it's something they enjoy. They like talking about decimals. And then the students who are language, well we're not looking at numbers, we're still looking at words. So all around, right? Whether you are at the store, whether you are planning a trip, whether, those things really do happen, um so i think the direction we have taken in the group where you are having conversations and using math terminologies that have becomes a conversation, i think it’s the way to go because it makes math less this just technical because math isn’t just technical 205. A: hmm 206. TEACHER B: that, that’s the big difference that i see now, math was technical but it’s isn’t, it’s actually 207. A: So three years ago you’d say math is technical? 208. TEACHER B: yes math is technical, it’s calculations, 209. A: ok 210. TEACHER B: whereas now even though i knew it was all around us videos I'm never sure about how to group the kids. You know? Like sometimes you see when it's the weak kids with the weak kids, they actually accomplish more, because they're not... (2) You know. Even if they haven't gotten to the answer, they just accomplish more. There's more discussion, they put themselves out there a little more. So that's the kind of thing I'm not really sure, after watching some groups. I know we often say to put a little bit of different strengths in each group, but I don't think I believe it, now that I've been observing. I don't think I believe that any more. I think I'm almost...not streaming, but you're kind of streaming in your own class. In a way it's more beneficial to them, for a bit. Maybe there needs to be a mix of that. Maybe you start off like that, and then once they've got that going and you could see they're confident, mix it up a bit. But I could see, it's not just putting them in
<table>
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<th>I think it's kind of nice for everybody.</th>
<th>211. A: ya</th>
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<td>173. AB: You capture more interest.</td>
<td>212. TEACHER B: whatever it's technical, but now i really feel like it's the way see it’s the way that the kids need to see, then they put an importance on it as well</td>
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<td>174. TEACHER B: Interest. Yeah. A lot of that repeat or restate works well too, because they're always on their toes a little more. And it's not always about, &quot;do you know the answer?&quot;</td>
<td>213. A: hmm</td>
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<td>175. AB: Okay.</td>
<td>214. TEACHER B: why is math important?</td>
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<td>176. TEACHER B: We're just talking. So it takes that pressure off. That component that I was saying, about not wanting to talk about it. Like I see my students who are my weaker students in math, participate much more in conversation, when we're just talking about math, versus/</td>
<td>215. A: so how do students learn math?</td>
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<td>177. AB and TEACHER B: /Solving.</td>
<td>216. TEACHER B: i think math should definitely be hands on, hands on and real experiences not just calculating so that's kind of where i am at, where how to really make them into real experiences, where you have the practice, because once you know how it’s all around the world or why something is all around the world, something as simple as, you know, taxes or sales, how to make it real now but have the practice time. So it’s putting them together, but i think there definitely has to be hands on real</td>
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<td>178. AB: Yeah.</td>
<td>groups. There's a whole...</td>
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<td>179. TEACHER B: Yeah.</td>
<td>110. AB: Do you see benefits to having these kinds of conversations around the clips from other classrooms? Like we watched a couple of clips and discussed. Was that beneficial?</td>
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<td>180. AB: Do you think some of your</td>
<td>111. TEACHER B: Yep, for sure. For sure. Because you hear of things, and challenges, that other teachers have, and what did they do, or their experience. And sometimes it makes you feel, &quot;okay I'm on the right track,&quot; or, &quot;okay now I know how to get on the right track.&quot; So I find it's always good to get feedback, and share. (3)</td>
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<td>thoughts on how we could improve the process of discussing, watching, discussing clips from different classrooms? Any thoughts?</td>
<td>112. AB: Any</td>
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<td>113. TEACHER B: Besides maybe - if we wanted to have more time - besides us watching it at home. But I think we</td>
<td>thoughts on how we could improve the process of discussing, watching, discussing clips from different classrooms? Any thoughts?</td>
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beliefs or thoughts about mathematics, about learning or teaching math, have changed as a result of what we've been doing on the project?

181. TEACHER B: Definitely. I think I said it before. I enjoy teaching math now. And I just recently had a student-teacher and I couldn't wait to show her these new things that were actually working, and to try it out, and to, you know, see where she could go with it. So yeah, oh definitely. Definitely.

situations where they feel like they can manipulate the situation through math,

217. A: hmm

218. TEACHER B: and see it’s purpose, there has to be a purpose, right? You always have a purpose or a need for something so.

236. TEACHER B: balancing all of that. Ya, ya, and then the fact that they still need to, you know, you want to have this kind of spiral method of math, but it’s hard to keep them practicing it all the time, that’s what i am noticing, it’s at the end of the year and they have all these exams which you know you have taught it all and i find they are very young to have to remember to retain it all, because it’s just hard to touch on everything all the time.

237. A: ya

238. TEACHER B: because they need the time to practice as all know that sometimes it's just impossible. I think it's fine the way it is.

122. AB: And just... It's not in my list, but how do you feel about this first year as teaching math?

123. TEACHER B: Oh I love it.

124. AB: Yeah?

125. TEACHER B: Yeah, and I never want to teach something else again.

126. AB: Okay.

127. TEACHER B: Yep. I never want to teach English again. That's for sure. [Laughs] I find it really interesting. Again, I think I've mentioned it in the classes, I feel like I'm more confident. (8) And things like, I'll be writing an answer on the board, and while I'm writing it... Okay I'll put it this way: when I used to teach English, or anything like that, I could be reading a story, and at the same time in my head, I was thinking, "oh I'll do this after, and this
well. So that’s where that, i dunno where that fits in, that rote practice,

239. A: ya

240. TEACHER B: there is still a place for it,

241. A: hmm

242. TEACHER B: but where?

279. A: what you are saying is more, what you have is good, but more if possible

280. TEACHER B: it’s good start, ya good start but for sure sharing, like i love sharing (8), like Kristie does, she always finds different things, and we just don’t have that chance to, like when we say what we did and then it would be nice to afterwards to have more chance: “ok now really show me how you developed it” and can you...?

after, and this after." I'd have creative ideas in my head while I was reading. When I was teaching math, it would be just, I'm teaching this math, and don't even ask me, "miss can we do it this way?" because I would start sweating. Like, "I don't know if you can do it that way." It don't come natural to me to find another way. I would've had to have looked, and it just wasn't natural. I find now I'm able to teach, and as I'm writing one way in my head I'm like, "or you could do it this way." And I'm feeling really a lot more comfortable with the material. (9) And what I'm really loving, is seeing other kids who were me, who are me before, who really came in saying "I hate math. I'm not good in math." And now... a child today just said, "miss I'm finding this situational problem pretty easy. I'm finding that, you know what? I'm looking at math a different way. I think I can get this."
128. AB: Wow.

129. TEACHER B: That makes me happy. To me, I know I'm not going to get the five kids who have difficulty, but if I get one, I'm really happy. Not just that they understood, their whole mindset has changed. They really... So that's what I've really gotten from it. I'm very excited about it. Very excited about that, because it's really not fun having a math phobia. It's around, and there's too many things in life that make you feel stupid, you know? "How much do you think that's going to cost?" [Laughs] You're like, "I don't know."

130. AB: Mhm. Good. Well I'd like to maybe next year, yeah, that we could spend more time looking at what happened in your life as a teacher, from year one of this project to year five. Because it's a very rich story.
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<td>131.</td>
<td>TEACHER B: Okay.</td>
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<td>138.</td>
<td>AB: So I have questions now about math, three questions. Math as a subject, math as a learning, and math as a teaching domain. So, how do you understand mathematics as a subject?</td>
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<td>139.</td>
<td>TEACHER B: As a subject.</td>
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<td>140.</td>
<td>AB: What is math?</td>
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<td>141.</td>
<td>TEACHER B: Math is the... It's kind of the base of many things in real life, I think. In real life. Like everywhere you look, whether there's statistics in a newspaper, like we said, grocery shopping. Math is just everywhere. Or something more complex is building a bridge or a house, right? It can go to any... But it's definitely the basics for many, many paths in life. So I think it's an important subject. Is that what you mean?</td>
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147. TEACHER B: Like, you do things with it. It's not just facts, it's not just an opinion. It brings you to something. Right? There's always a next step, and a next step. Because even if you get an answer to something else, well maybe you could do it another way. You know? It's...

148. AB: It's a dynamic, moving... Yeah.

149. TEACHER B: Yeah. Like I used to always think, I used to always think that you do something and then you have an answer. Now I think that that's actually not true at all. It's actually the opposite. [0:30:47.3] There's not an answer, there's always other things. But if you change, or if this happened, it's just as changing as, I don't know, a discussion that you might have in English about different opinions. What if this would have happened? I think math's just as changing and moving. Yeah, I guess dynamic.
Definitely something that's - this level math - tangible. Like you can see... You can actually see math.

Whereas, you know, you don't necessarily see other things. You can't make it happen, whereas you can make math happen in front of you. If that makes any sense.

152. AB: What do you think students should learn from math classes?

153. TEACHER B: I think that they should learn that not everybody learns this stuff at the same pace. That, you know, it's okay to take your time. But I think it is important... See when we first started the project I thought, somethings you just have to know, and it didn't matter the background, because, right? That's how I was taught. I think I even used to say, like, "just get the answer with cross multiplication. Just do it." Right? But now I see why it's important not to just do it. Because then
you end up lost like me, not really knowing much about anything. But just, "okay here's the answer." So I think now, I think kids should learn why. Why does cross multiplication work? Because of, you know, equivalent fractions. And how does that...? I think it's important for them to know the basics, because it gives them more of an understanding of why it's working, and maybe, hopefully, I'd hope that they'd then know what formulas to apply, because they can visualize what's happening behind each formula, I guess. And I think that is important. That has changed over the years. And I see it so much. So that when there's someone coming to help, and they're using cross multiplication, I'm like, "no! Don't use cross multiplication." [Laughs] Wow. And I find myself... or, you know, they'll say, "it's going to be easier if you just do this. For high school they just need to know this."
And I'm really against it now. Like no, no, no, no. Give them the building blocks, so that it's a solid foundation to understand why, besides the multiplication facts. But even then they should understand that it's groups of, right? Three groups of eight. I still see that as well.

154. AB: Okay. What are the building blocks?

155. TEACHER B: Building blocks... I think it's addition, subtraction, multiplication and division. I really do.

156. AB: The operations.

157. TEACHER B: Yeah. I think it's that, for sure. But understanding what they are exactly, in tangible... Like in 3D. What does that mean? Because in the end, everything kind of is... you're always putting things together anyway, whether it's multiples of, or dividing it up. In the end that's what you're doing. And
your percentage, it's that. Everything. Even geometry, right? We're always cutting it up and dividing it up. So I think it's really important to know what they mean. You need to know them by heart as well. That I will not back down on. You do. Even though there's calculators it doesn't matter. You need to know them. But really know what it means.

158. AB: Okay.

159. TEACHER B: Because I find kids still, "oh you just calculate it," and they still don't know. But what are you doing? Which one are you doing? Which operation are you performing? Because you're either putting it together, or taking it apart, or taking it away, right? In almost all the things we do.

160. AB: How would you describe your teaching or your role, in the math class?

161. TEACHER B: [Sighs] As a
facilitator. To really show them that they can understand it, you just have to figure out which way is going to be the way for them to understand it. Like there's always a way to understand math. You just need to find which connection, which picture, which visual, which step is going to make it clear for you. And...

162. AB: So how do you do that?

163. TEACHER B: By showing different ways, or asking how someone did it, or why does that work? You know if someone has a different way, "oh, and why does that work?" That worked for him. And to find out who did it this way, who did it that way. And to show how we always come up with the same number. [0:35:01.1] They get very excited. Like, "oh yeah, five this way," "we got five that way," "ah, we got five this way. Isn't that amazing?" And to show them that it can be fun, too. Fun, and it's not... It's fun
even if you're not fast at it. It's still fun. Because I think a lot of kids just come in and are like, "I hate math." And they hate it because they're not good. Period. And I have students that still get twos, and they like math. And that's okay. [Laughs]

164. AB: Yeah, yeah. You mentioned earlier that your brain changed as a result of the project.

165. TEACHER B: I feel like it did, yeah.

166. AB: But... So your thoughts and your beliefs about math and about learning math, and about teaching math have changed?

167. TEACHER B: They've changed, but I also think differently. I really see things differently. I really... I think I mentioned it, sitting in situations where people are talking about things that are math subject related, I would really just sit there and over my head. I shut... I guess, because perhaps right away I decided, "If
don't understand this," or I don't know, whatever. Now I can sit in there and I'm not even thinking, I understand. So I feel like, yeah... I feel because of the mindset and the attitude changed, it also, I guess, lifted that block I had to even allowing myself to think math-y, in numbers, or in... and get excited about it. (10) Because it was always just, "ugh why would I want to do that?" You know? Why would I want to sit and calculate things?

168. AB: So, you experienced an important shift in your/

169. TEACHER B: / Yes.

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