Grade 9 Mathematics in Manitoba: Reforming the way we teach

by

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ABSTRACT

The purpose of this study is to gain an understanding of the experiences of Grade 9 Mathematics teachers to better understand their role in enabling success for all students. This is the phenomenon under investigation. The central question that frames this research is: What are the underlying features of the experiences of Grade 9 Mathematics teachers in Manitoba who are reforming Grade 9 Mathematics education? From information gained through interviews with a purposeful sample of six teachers, classroom observations, and member-checks, this study provides insights into various teaching methodologies and strategies used in Grade 9 Mathematics classrooms to better create conditions for student success.

The findings of this study affirm that enabling student success extends beyond changing the technical modes of teaching. It also includes (a) shifting from teacher-centered instruction to building a classroom community, (b) changing teachers' role as knowledge experts to becoming learning facilitators, (c) building student competence and confidence cumulatively, (d) receiving support from multiple stakeholders from within the larger educational system, and (e) effectively promoting student accountability and co-ownership of learning.

Teachers in this study are reforming their practices because they are committed to achieving a higher purpose in their classrooms. They are all committed to balancing (a) enabling conditions where students become autonomous, responsible, and critical participants in their own learning, and (b) building a classroom community where students are encouraged to collaborate, communicate, and take co-ownership for the learning of their peers and therefore are engaged in a sense of social responsibility.

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Chapter 1: Introduction of Thesis Topic

My Journey to Becoming a Teacher

I derive great satisfaction and enjoyment from helping others learn. I have had this attribute from a young age, whether it was helping out a peer in class with their homework, or helping my younger sister with practicing the piano, or helping a new employee learn the cashier register system at the restaurant where I worked. It was this enjoyment of helping others learn that inspired me to become a teacher. I discovered that I enjoy working with teenagers, and while at university the focus of many of my part-time jobs involved working with children and teenagers. These experiences clarified my passion and interest to work with high school students as a teacher.

I graduated from the Faculty of Education at the University of Manitoba in 2010. Upon graduation, I worked as a high school chemistry and general science teacher at St. Paul's High School in Winnipeg, Manitoba. After completing my one-year term, I was offered an opportunity to teach mathematics at West Kildonan Collegiate in Seven Oaks School Division. I have been teaching at this school since 2011. Over the last eight years, I have had the opportunity to teach mathematics courses which include Grade 9 Mathematics, Grade 10 Introduction to Applied and Pre-Calculus Mathematics, Grade 11 Pre-Calculus Mathematics, and Grade 12 Essential Mathematics. One of the most exciting aspects of being a teacher in the same school for this length of time is that I have been able to meet, teach, and learn from some students in multiple years of their high school career. I find it rewarding to having students in my mathematics class on the first day of Grade 9 and then meet them again in my Grade 11 or 12 classes. I find it satisfying and exciting to watch students grow and mature as mathematics students and as young adults over the course of their high school career.

My Role as a Mathematics Teacher

Teaching mathematics for the past eight years has been a source of enjoyment in my professional life. I gain the most enjoyment from teaching mathematics when I am able to successfully create conditions for students to learn new concepts and skills and then watch them gain confidence in themselves and their learning. I enjoy promoting activities in my classroom that generate mathematical discussion and inquiry amongst students, and one of my favorite sounds in my classroom is hearing what I call "math talk" between students, without necessarily needing my input or guidance.

As I have grown in my profession as a mathematics teacher, my approach to teaching has changed. In the earlier years of my career, my views and ideas about teaching were what I would now call traditional and teacher centered. My own schooling experience, especially in high school classes, was predominantly characterized by direct teacher instruction. While this was a positive experience, it moved me to develop a narrow view of teaching and learning. I came to believe that as the teacher, I should be the expert on the topics I was teaching, and that my job was to stand in front of the classroom and expertly impart my knowledge. In this research study, I shall refer to this understanding of expert as 'knowledge expert.'

As a teacher candidate, I would study my own notes to make sure that I was completely confident in the concepts I was teaching and mentally rehearse my lessons while driving to school to make sure that I didn't fumble with my words or forget anything when in front of my students. To be frank, I viewed teaching more as giving lectures, especially in higher-level courses such as Grade 11 and 12 Pre-Calculus Mathematics, where I was the deliverer of information. I viewed my students as "empty vessels" (Freire, 1970, p.57) who were eager to receive, understand, and later repeat the knowledge I was bestowing on them. This "banking

concept of education" (p.57), where my perceived role was to deposit information through a direct-instruction method of teaching, allowed me to feel competent and confident as a mathematics teacher. I was able to give students the information they needed throughout the course and prepare them for a final exam where they would repeat the expected content. In addition, I believed that my students liked this method of teaching. Their job, I thought, was to sit in class and watch me do the work and follow my steps and examples. This direct-instruction method included offering my students an opportunity to practice what they learned on their own and prove that they knew the steps on a summative assessment. I believed that if students saw me as an expert in mathematics, they would have an increased confidence in me. What I do know, is that this method of teaching increased my own self-confidence in being a teacher.

As I have moved through my teaching career, I learned a great deal from my colleagues and other professionals who work in mathematics education. At the same time, in the interest of creating conditions for student success, I continually examined and reflected on my own experiences in my classroom. Both these aspects of professional learning have inspired me to significantly alter the way I view the process of teaching and learning mathematics. The most noteworthy change is the efforts I have made to shift mathematics learning from a teacher-centered process to a student-centered process. I have been purposefully working to become less of what educators sometimes refer to as a 'sage on the stage' where students' learning is dependent and centered around me as their teacher. I am learning instead to be what we call an informed 'guide on the side.' I have focused my professional development and learning on this aspect of mathematics education for the past six years and it is a continuous learning process, as I experiment with different teaching methods in my own mathematics classroom. My goal in my mathematics classroom is to empower students to learn the mathematics content with informed

guidance rather than direction, by providing them with the tools and skills to access the content and use it in meaningful and applicable ways.

Classroom Challenge.

This goal has proven to be lofty and challenging for two critical reasons. First, high-school mathematics courses, by their very nature, are very skill-based and content-focused. I find that it has been difficult to strike a balance between providing significant opportunities for student-centered learning and inquiry while also being teacher-centered in covering the curricular content that the province of Manitoba mandates. Second, while I believe that there is an enormous learning potential for student-centered learning, I find that students are weary of student-centered math activities because they feel that, as some of my students have voiced, "they are not being taught and therefore "are not learning." Student-centered learning requires students to step outside of their comfort zones. I find that students are more comfortable with the more traditional, teacher-centered teaching method of what I refer to as the idea of 'I lecture; you listen,' because they feel like they are learning from me. Their expectations and my experience have created some degree of angst both for the students and for me.

However, despite these challenges, I have constantly and continually tried to learn and try different teaching methods in my mathematics classroom with the goal of creating conditions for students to access curricular content and use the skills they learn in meaningful and applicable ways. The endeavour to reach this goal in my mathematics classes has taken me on a journey through learning about and experimenting with different student-centered teaching and learning methods – most notably, what is referred to as 'flipping' and 'blending' my classroom.

Flipping and Blending Methods of Teaching and Learning

Using flipping and later blending teaching and learning methods in my Grade 10 Introduction to Applied and Pre-Calculus Mathematics classes was my way of striking a balance between creating a student-centered learning environment and making sure that students received the curricular content (teacher-centered).

The flipped classroom is a process where instructors pre-record lectures and post them online for students to watch on their own before coming to class. This subsequently allows more time *in* class to be dedicated to student-centered learning activities, such as problem-based learning and inquiry-oriented strategies. This approach provides instructors with opportunities to engage a wide range of learning styles and implement pedagogies that encourage problem-solving during dedicated class time (McLaughlin et al., 2014). The second student-centered teaching and learning method I experimented with my Grade 10 Introduction to Applied and Pre-Calculus Mathematics class was a blended teaching design where students learn through digital or online methods such as interactive activities and delivery of content through videos while in the classroom. This process enabled students to control the time, path, and pace of the content delivery and activities while the teacher is present, and still have access to the content outside of class time.

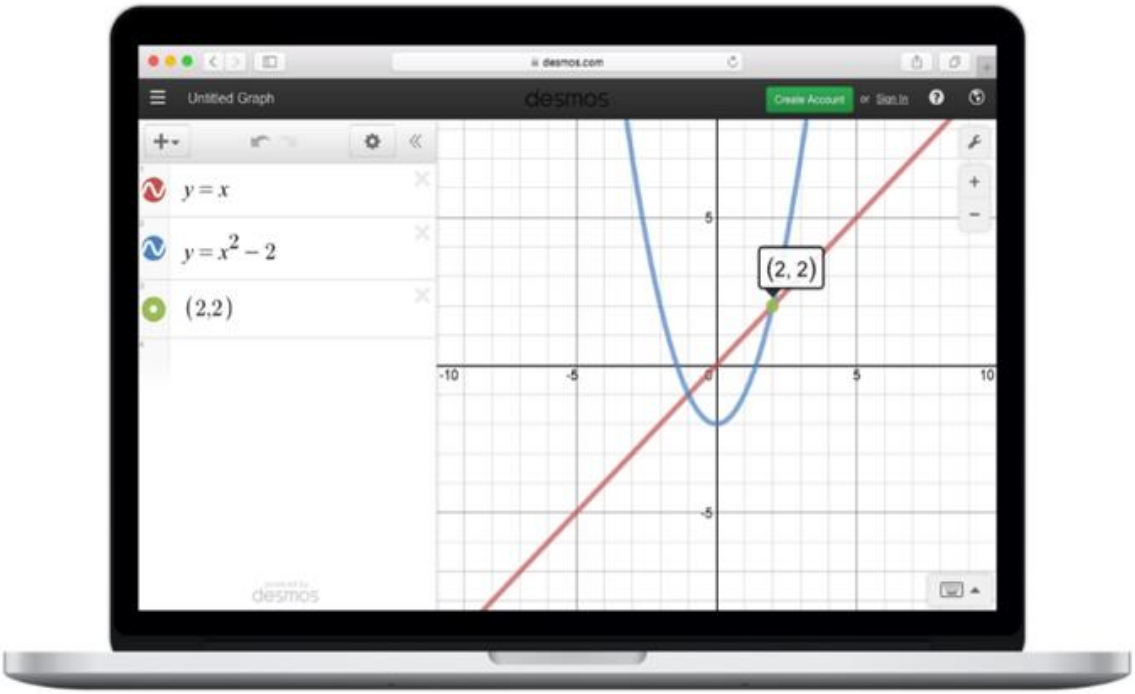
My experience with both alternative teaching designs were positive. Flipping my classroom allowed for more time in class to engage students in small group and problem-solving activities. By requiring students to do a short online quiz after they had watched the video lectures, and before they entered class the next day, I was able to immediately do a formative assessment as to whether or not they understood the basic content of the video lecture. This made it possible for me to check-in with students who were having difficulties with the course content

almost immediately, and this process enabled me to address the issue sooner rather than later. However, as I experimented with this teaching method, I realized that one negative aspect of a flipped classroom is that it still requires students to passively watch a lecture on the mathematics content. While my face-to-face time was spent flexibly on interactive and engaging activities, I was still requiring students to watch a video of me lecturing before they came to class. I was not satisfied with this process because it still placed me in the role of being a sage on the video stage. It was, in other words, another form of teacher-centered teaching. I wanted to find a teaching methodology that would not only allow time for these learning activities, but also provide students with an opportunity to access the content and skills without requiring me to lecture.

This led me to a blended teaching methodology. I received my inspiration from a colleague who introduced me to the work of mathematics educator Alice Keeler (2018). More specifically, my colleague directed me to Keeler's use of Google Sheets in what she called the 'gamification' of mathematics. In this type of a blended learning situation, students worked through a series of online teacher-created tasks and activities that were organized in their own Google Sheet. When they accomplished each task, they received an online badge and proceeded to the next level. I found that this teaching method was positive in that students could work through the activities at their own pace. Also, I was able to introduce students to different methods of accessing the curricular content such as online videos and tutorials, and inquiry-based activities through free online programs such as Desmos.

Developed by Eli Luberoff, a math and physics double major from Yale university, Desmos is an online program that allows teachers to not only create math activities and games for students but also to keep track of student progress and understanding from the teacher page. While teachers can create graphs to display and share with the class, Desmos also enables

students not only to graph functions, plot tables of data, and explore transformations, but also see the results of their work on screen as they manipulate their graphs. An example of what students are able to view is displayed in the Desmos screenshot below (Source [www.desmos.com)](http://www.desmos.com).



I found that using this alternative teaching method allowed me to become more of an informed guide who helped students access, understand, and interpret the content rather than simply being the deliverer of knowledge.

Experience

Both of these teaching experiments worked well within the context of my Grade 10 Introduction to Applied and Pre-Calculus Mathematics classes. I was able to achieve the goal of balancing teacher-centered learning and student-centered learning in the classroom. When I tried

elements of both of these teaching methodologies with my Grade 11 Pre-Calculus Mathematics classes, I had similar positive experiences.

My positive experiences with my Grade 10 and 11 classes led me to experiment with using these alternative teaching methods with my Grade 9 Mathematics students, with the goal of offering them a more meaningful mathematics education experience. However, as I began to do this, I found the venture to be quite challenging. For example, when I flipped a portion of a unit in Grade 9 Mathematics, I discovered that a significant number of my students were not watching the videos before they attended class and therefore were confused during the in-class activities. When I introduced a blended teaching methodology in a different unit, many students rushed through the online tasks and activities to get their badges and proceed to the next level without really understanding the content. They were more focused on finishing the unit as opposed to making meaning from the activities.

General Research Topic

The differences I experienced in students' behaviors and attitudes towards mathematics learning in Grade 9 Mathematics classes, compared to what I had experienced in my Grade 10 and 11 classes, moved me to become more curious and interested in learning about facilitating success in Grade 9 Mathematics. In my Master of Education course work, as well as in the previous course work for my Post-Baccalaureate Diploma in Education, I focused on the issue of transition of students from middle school to high school. My interest motivated me to consider completing a research project that focused on this very issue. However, through many discussions with my colleagues and other mathematics educators, as well as reflecting on my own experiences and interests, I became aware that the transition from middle school to high school is just one aspect of what I was really interested in. I realized that this issue of transition

simply provides the background context for what I wanted to research. While the transition of students from middle school to high school mathematics provided a context and possible explanation of student attitudes and behaviors towards mathematics education in Grade 9, I was more interested in learning how to better cultivate and encourage positive student attitudes and behaviors in my math classroom, and how to minimize and discourage defeatist and negative attitudes towards mathematics.

In addition to noticing the difference in student behaviors and attitudes in Grade 9 Mathematics compared to student attitudes and behaviors in Grades 10 and 11, I found that another issue was prevalent among Grade 9 Mathematics students. The ninth grade is the last year in the Manitoba curriculum where students are required to take the same mathematics class as all of their peers, regardless of their skill level or interest in pursuing mathematics in later years. This issue bears a little more discussion. However, before continuing with this discussion, allow me to offer a background on the organization of high school mathematics in Manitoba, as it will serve as a context for understanding what is at stake in this case.

High school mathematics in Manitoba.

Currently, Grades 10-12 mathematics in Manitoba is organized into three pathways: Pre-Calculus Mathematics, Applied Mathematics, and Essential Mathematics. According to the *Grades 9-12 Mathematics: Manitoba Curriculum Framework of Outcomes* (2014) [I will refer to this from now on as the Manitoba mathematics curriculum], "there is one course available for students in Grade 9. In Grade 10, students may choose between two courses or may choose to take both courses (Introduction to Applied and Pre-Calculus Mathematics, and Essential Mathematics)" (p.16).

Authors of the Manitoba mathematics curriculum (2014) further explain that, in Grades 11 and 12, students have three choices for courses (Applied, Pre-Calculus, and Essential Mathematics) and may take one or multiple courses. The three mathematics pathways are defined as the following:

> Applied Mathematics*:* this pathway is designed to provide students with the mathematical understandings and critical-thinking skills identified for post-secondary studies in programs that do not require the study of theoretical calculus. Topics include financial mathematics, geometry, logical reasoning, measurement, number, relations and functions, and statistics and probability.
>
> Essential Mathematics: this pathway is designed to provide students with the mathematical understandings and critical-thinking skills identified for post-secondary studies in programs that do not require further study in advanced mathematics. Topics include algebra, geometry, measurement, number, statistics and probability, and financial mathematics.
>
> Pre-Calculus Mathematics: this pathway is designed to provide students with the mathematical understandings and critical-thinking skills identified for entry into post-secondary programs that require the study of theoretical calculus. Topics include algebra and number, measurement, permutations, combinations and binomial theorem, relations and functions, and trigonometry (p.17).

The curricular outcomes of the Grade 9 Mathematics course are designed to give students access to the concepts and skills that will be useful in all three pathways of high school mathematics in Manitoba. However, the content in the ninth-grade course appears to be heavily geared towards students who are intending to enroll in the Pre-Calculus or Applied mathematics

pathway. In my experience, students who planned to enroll in the Essential Mathematics pathway in Grade 10 can find the Grade 9 Mathematics course extremely difficult. The general attitude amongst mathematics teachers at my own school towards students who are struggling in Grade 9 Mathematics, is to just get them through because they will be fine when they get to Grade 10 Essential Mathematics. This attitude, however, does not resolve the not-so-positive attitude and behaviors of Grade 9 students who have no intentions of enrolling in either the Pre-Calculus or Applied Mathematics pathways. My experience of students in my Grade 9 classes was that this group of students became discouraged, and as a consequence, also became disengaged from learning mathematics. In addition to this course being difficult for the aforementioned students, I have found that the students who have a stronger aptitude and higher interest in mathematics can also find themselves at a disservice with this course. Along with many other teachers that I have talked with, we have significant concerns about these students who find this course too easy, and hence feel under-challenged. This experience precipitated my research interest: What can I, as a Grade 9 Mathematics teacher, do to enable conditions for success for *all* students?

Research Focus

My combined love, care, and concern for enabling success among all Grade 9 Mathematics students who have varying skill levels and interest in mathematics, informs and grounds my proposed research project. As a teacher, I am fully aware that I am responsible for preparing *all* students well for *all* pathways within the same class. Subsequently, in this proposed research project, I choose to focus on how my colleagues, and I can teach Grade 9 Mathematics in ways that help *all* students find success and engagement in mathematics.

Through conversations with colleagues both within and outside my own school division, I discovered that one way that several school divisions and administrators in Manitoba are attempting to help all ninth-grade students find success in this Grade 9 Mathematics course is by implementing structural changes to the school timetable. Examples of schools which have implemented different types of structural change in their timetables include the following.

i. West Kildonan Collegiate has provided students with 1.5 times the amount of time to take the one credit Grade 9 Mathematics course;

ii. Sisler High School has provided students with 2 times the amount of time;

iii. At Steinbach Regional Institute School, prior to starting their regular Grade 9 Mathematics course, all students are required to take Senior 1 Transitional Mathematics in the first semester;

iv. At Maples MET School and Seven Oaks School Division MET School, students earn their Grade 9 Math credit alongside other credits through cross-curricular project work throughout the entire year;

v. Dakota Collegiate expects all Grade 9 students to take a required course focusing on general study and comprehension skills and habits, including the field of mathematics, with the goal of helping students with the transition from Grade 8 to Grade 9.

The scope of this study will include teachers who are in situations where structural changes have been implemented to provide them with more time to teach the Grade 9 Mathematics course. I believe that by using this delimitation factor, I will be more likely to find teachers who have used the extra time as an opportunity to adapt, change, or reform their teaching methods, and thus better enable student success.

Research Purpose

The purpose of this research project is to gain an in-depth understanding of the experiences of Grade 9 Mathematics teachers to better understand their role in enabling student success. This will provide insight into the different teaching methodologies and strategies that might be used in Grade 9 Mathematics classrooms to better create conditions for student success. The central question that will frame my research is: what are the underlying features of the experiences of Grade 9 Mathematics teachers in Manitoba who are trying to reform Grade 9 Mathematics education? Specifically, three questions that will guide this research are:

1. What are the non-traditional teaching methods and strategies being used by a purposeful sample of Grade 9 Mathematics teachers?
2. How are these non-traditional teaching methods and strategies aligned with their own goals and the goals of mathematics education as defined by the National Council of Teachers of Mathematics (NCTM) and the Manitoba mathematics curriculum?
3. What explanatory factors underlie the positioning's of these teachers whose total time for the course allows them to adapt, change, or reform their instructional methods?

My hope is that by learning from teachers who may be teaching this Grade 9 course in substantially different ways, I might better inform myself and other teachers on how they might teach Grade 9 Mathematics to help *all* students find success.

Summary

In this chapter, I outlined my journey towards the profession of my choice, my experience as a mathematics teacher, my experimentations with alternate methods of teaching, and I raised the experiences of Grade 9 students who find themselves in one course but soon moving to different mathematics pathways. As noted earlier, my fundamental concern is to

prepare *all* students within the same course well for *all* pathways of mathematics in Manitoba. How then can I be inclusive of all student interests in the Grade 9 mathematics classroom? What can I do to enable *all* students to be successful in learning mathematics? This, as I noted in this chapter, is both the purpose and focus of my proposed research. Before turning to the methodological features of this research project, I will first explore the theoretical foundations for students' success as reflected in the literature.

Chapter 2- Theoretical Foundations

As noted in Chapter 1, the central question that will frame my research is: what are the underlying features of the experiences of Grade 9 Mathematics teachers in Manitoba who are trying to reform Grade 9 Mathematics education? Specifically, three questions that will guide this research are:

1. What are the non-traditional teaching methods and strategies being used by a purposeful sample of Grade 9 Mathematics teachers?
2. How are these non-traditional teaching methods and strategies aligned with their own goals and the goals of mathematics education as defined by the NCTM and the Manitoba mathematics curriculum?
3. What explanatory factors underlie the positionings of these teachers whose total time for the course allows them to adapt, change, or reform their instructional methods?

It is with these questions in mind that I turn to the literature to explore the theoretical foundations for students' success within the framework of the NCTM and the Manitoba mathematics curriculum.

Chapter 2 will be subdivided into three parts. In Part I, I will offer an overview of the goals of mathematics education as defined by the NCTM and the Manitoba mathematics curriculum. The NCTM outlines their goals of mathematics education in the *Principles to Actions: Ensuring Mathematical Success for All* document (2014). The provincial goals that are specific to high school students are described in the province's Mathematics curriculum document, *Grades 9 to 12 Mathematics Manitoba Curriculum Framework of Outcomes* (2014), which I have been referring to as the Manitoba mathematics curriculum. It is important to note

that the NCTM document and the Manitoba mathematics curriculum both contribute to a collective effort to better help students learn mathematics and to enjoy the process. In looking at the aims of both documents, I hope to provide the background information necessary to understand the broader goals of what high school mathematics teachers are trying to achieve in their own classrooms in Manitoba.

In Part II, I will discuss the issues associated with students transitioning from a middle school or junior high classroom (Grade 8) to a high school classroom (Grade 9). I do this for the purpose of providing a context as to what teachers are dealing with, specifically in regard to Grade 9 classrooms, while attempting to meet their own goals and the goals of NCTM and the Manitoba mathematics curriculum.

Finally, in Part III, I have organized some of the literature relevant to my study regarding how scholars and practitioners respond differently to achieve these goals of mathematics education in high school math classrooms. As reflected in the literature, these responses, which align well with the NCTM goals and the Manitoba provincial goals of mathematics education, can be categorized into four themes. These themes include (a) the occurrence and frequency of mathematical tasks that promote problem-solving and critical-thinking, (b) supporting productive struggle and risk-taking when learning mathematics, (c) facilitating meaningful mathematical discussion, communication, and discourse, and (d) the purposeful integration of technology into the mathematics classroom.

Part I: Goals of Mathematics Education

The NCTM (2014) outlines five goals of mathematics education in high school in their publication *Principles to Actions: Ensuring Mathematical Success for All*. This document references the National Research Council (2001): “the learning of mathematics has been defined

to include the development of five interrelated strands, that, together, constitute mathematical proficiency" (p.7). The points below paraphrase the five NCTM goals:

1. *Conceptual understanding*: the comprehension and connections of different concepts, operations, and relations in mathematics;
2. *Procedural fluency*: the meaningful and flexible use of mathematical procedures to solve problems;
3. *Strategic competence*: this is described as the student's ability to formulate, represent, and solve mathematical problems;
4. *Adaptive reasoning*: the student's ability to think logically and justify their thinking; and
5. *Productive disposition*: "the tendency to see sense in mathematics, to perceive it as both useful and worthwhile, to believe that steady effort in learning mathematics pays off, and to see oneself as an effective learner and doer of mathematics (NCTM, 2014, p.8).

The broader goals of the NCTM are in strong alignment with the six main goals described in the Manitoba mathematics curriculum (2014) where the main goals of mathematics education are described as preparing students to:

1. Communicate and reason mathematically;
2. Use mathematics confidently, accurately, and efficiently to solve problems;
3. Appreciate and value mathematics;
4. Make connections between mathematical knowledge and skills and their applications;
5. Commit themselves to lifelong learning; and

6. Become mathematically literate citizens, using mathematics to contribute to society and to think critically about the world (p.5).

Table 1 below makes apparent the close alignment between the goals of the NCTM and the Manitoba mathematics curriculum.

Table 1: Aligning the goals of the NCTM and the Manitoba mathematics curriculum

NCTM	Province of Manitoba
Conceptual understanding: the comprehension and connections of different concepts, operations, and relations in mathematics.	Make connections between mathematical knowledge and skills and their applications.
Procedural fluency: the meaningful and flexible use of mathematical procedures to solve problems.	Use mathematics confidently, accurately, and efficiently to solve problems.
Strategic Competence: this is described as the student's ability to formulate, represent, and solve mathematical problems.	Communicate and reason mathematically. Use mathematics confidently, accurately, and efficiently to solve problems.
Adaptive Reasoning: the student's ability to think logically and justify their thinking.	Make connections between mathematical knowledge and skills and their applications.
Productive Disposition: "the tendency to see sense in mathematics, to perceive it as both useful and worthwhile, to believe that steady effort in learning mathematics pays off, and to see oneself as an effective learner and doer of mathematics."	Appreciate and value mathematics. Commit themselves to lifelong learning. Become mathematically literate citizens, using mathematics to contribute to society and to think critically about the world.

The alignment shown above suggests that the goals of teaching mathematics are more than simply enhancing students' skills in mathematics. Productive disposition, as noted above, is about preparing students to become "mathematically literate citizens" who are able to use "mathematics to contribute to society and to think critically about the world" (Manitoba

mathematics curriculum, 2014, p. 5). These goals are ambitious, but they are both necessary and desirable in order to prepare students both for doing mathematics and for mathematically literate citizenship.

The challenge for Grade 9 teachers is to teach mathematics in ways that are aligned with the goals of both the NCTM and the Manitoba mathematics curriculum, but also to teach mathematics within the context of the transitional experiences of Grade 9 students.

There are several critical changes that Grade 9 students typically experience, such as:

- experiencing high school mathematics for the first time, and usually at a new school,
- working towards a credit requirement in a course, and
- the requirement to choose mid-year which mathematics pathway they want to enter in Grade 10.

The challenge for teachers, then, includes discovering how we can teach Grade 9 Mathematics in ways that achieve the larger goals described above without alienating or frustrating our students' attempts to understand and use mathematics confidently, accurately, and efficiently. As a mathematics teacher, this is why I am the most interested in this grade level; I want to be in a position where I can better support students' learning and understanding of mathematics in Grade 9 as they maneuver through this transitional time from middle school to high school, so that they might have a more positive and successful high school mathematics education.

Part II: Context- The Transition into High School Mathematics

In order to provide a context for my research purpose, I will examine the research that has been done on the experiences of students as they transition into high school. Within the context of my proposed research, it is imperative that we further examine this literature because of the correlation that has been identified between not earning grade 9 credits, and the decreased

likelihood of graduating (Midgley, Feldlauger, and Eccles, 1998). The significance of the ninth grade on high school graduation is not just a concern in Manitoba. McCallumore and Sparapani (2010) have coined this the ninth-grade problem and suggest that "ninth grade is the make or break year for completing high school" (p.447).

Similarly, in an issue brief prepared for the Washington State Student Achievement Council on the factors influencing high school graduation, Ritter (2005) identified the influence of ninth grade as the second most important factor, after economic status, predicting the likelihood of high school graduation.

> Evidence is growing that students who fall off track during the freshman [Grade 9] year have very low odds of earning a high school diploma. Analysis of the progression of students through high school suggests that approximately one-third of the nation's recent high school dropouts never were promoted beyond ninth grade (Ritter, 2005, p.5).

Provincially, Manitoba Education and Training (2019) acknowledges the significance of succeeding in Grade 9 Mathematics:

> Grade 9 is the first year in Manitoba schools when students must pass core courses toward earning their high school diploma. For many, this transition year can mean declines in academic achievement and increased absences among other social factors that impact their success. … Research shows that success in Grade 9 credit attainment is a critical determinant of a student's likelihood of successfully completing high school. (Para 8)

As mathematics teachers we must examine the reasons why students find this transition year so difficult. The literature offers a wide variety of factors that contribute to this decrease in academic achievement for many students when they begin high school.

One recurring theme is a decrease in the student-teacher relationship, as perceived by the student. This decrease may in part be due to the departmentalization structure of traditional high schools. Midgley, Feldlauger, and Eccles (1989), for example, believed that systemic changes in the classroom environment as children move from elementary school to junior high and then on to high school contribute to the decline in motivation and performance in mathematics. They suggested that "the value of math increases for students who move from less supportive to more supportive teachers after the transition and decreases for those who experience the opposite pattern of change" (p. 988). Barber and Olsen (2004) echo this sentiment: "On the average… teachers in larger schools are less personal compared to the smaller, single-teacher environment of elementary and middle school" (p. 4). Students may perceive teachers to have less of a relationship with them because of the little time they spend with each teacher in high school as compared to middle school. Similarly, Midgley et al. (1989) state, "the departmentalization organization of high schools may inhibit the development of positive teacher/student relationships because students spend less time with each individual teacher" (p. 989).

It is also important to note the impact of how the typical Manitoba public high school is structured in terms of Grade 9 Mathematics. In order for students to earn the standard Grade 9 Mathematics credit, students are scheduled for Grade 9 Mathematics for an average of one hour per day in a semester system or every second day all year in a non-semester system. In total, students spend their Grade 9 year enrolled in approximately 8-10 one-credit courses, where Mathematics is just one of them, and students typically have a different teacher for each of these courses. Therefore, while students may have only had one or two teachers in middle school, they are exposed to potentially seven or eight different teachers in different classrooms in the traditional high school structure. The "larger schools and grade size," according to Barber and

Olsen (2004), “is seen to affect the well-being of students by being less personal, including increased anonymity, (and) less teacher support” (p. 5). Mizelle and Irvin (2005) agreed that the reason young adults frequently have a difficult time making the transition into high school is because they experience a larger, more impersonal, more competitive and grade-oriented environment than they experienced in middle school (p. 3).

Substantial academic differences and expectations between middle school and high school is the second recurring theme that is offered to help explain the reasons for the difficulty in transition for students when they enter high school. High school is the first time that students earn credit for graduation over the course of four years, and unfortunately some students do not realize the importance of the ninth-grade year (McCallumore & Sparapani, 2010). As Benner and Graham (2009) stated, “for many students, entry into ninth grade is their (students) first exposure to a completely departmentalized curriculum, extensive academic tracking, ordering of ability via class rankings, and recurrent reminders of graduation requirements” (p. 356).

A third explanation about the reason why ninth grade poses difficulties for some students is that ninth grade coincides with life-course changes, such as reduced parental supervision and increased peer influence. Neild (2009) asserted that, although the transition to ninth grade does not necessarily occur alongside the dramatic physical changes of early adolescence, a number of studies have shown that parental influence wanes when children enter high school. He offered the example of how many parents decide to grant greater autonomy to their children at this transition point from middle school to high school. He noted that the reduction of parental supervision and support, accompanied by the increase in peer influence that characterizes adolescence, may result in increased risk-taking behaviors and declining academic performance in grade 9 (Neild, 2009, p. 58).

Ellerbrock and Kiefer (2014) created a program called the *Freshman Focus* to respond to the ninth-grade problem, in which ninth-grade teachers created a community of care focused on responding to students' basic and developmental needs and how to best support young adolescents transition into ninth grade (p. 6). The authors note that a program such as this is part of a process, and that such efforts have a lasting, positive impact on students and their development (Ellerbrock & Kiefer, 2014, p. 9).

These studies demonstrate that there is a correlation between being unsuccessful in Grade 9 and decreased graduation rates, and they offer possible explanations about why this transition year is so difficult for many students. In tracking Manitoba's high school graduation rates, administrators within Manitoba Education and Training (2019) noted that "Manitoba's four-year student-tracked high school graduation rate for 2017 is 78.9%. For non-indigenous students the rate is 86.6% and for Indigenous students it is 49.3%" (para 5). In more recent statistics offered for grade 9 math specifically in Manitoba, we notice that over a tenth of our Grade 9 population are not meeting the goals of mathematics education in Manitoba, and they are also at a much higher risk of not graduating. Figure 2 below illustrates the percentage of Grade 9 Mathematics students who earn a credit by the end of the school year, and in the most recent school year this percentage was at 88%.

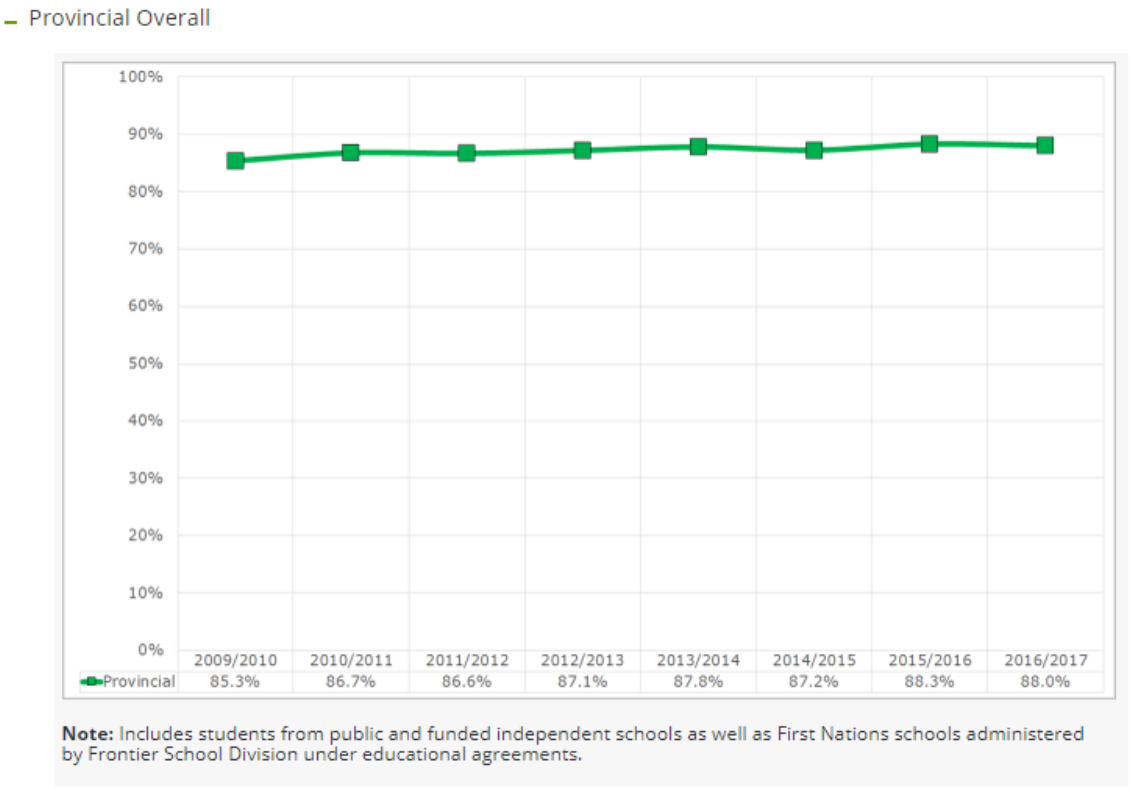


Figure 1. The percentage of first-time Grade 9 students who attained a Mathematics credit by year-end in Manitoba.

Source : http://www.edu.gov.mb.ca/k12/grad_rates/index.html

The data provided by Manitoba Education and Training (2019) demonstrates that the Grade 9 Mathematics classroom is one in which students are having difficulties, and these difficulties could result in a lack of a credit and therefore a decreased chance of graduation. Therefore, I would assert that, as a collective group of teachers, we need to rethink how we prepare students in the Grade 9 Mathematics classroom with the purpose of helping all students find success.

I will now turn my attention to this rethinking and attempts to change Grade 9 teaching practices as they are presented in the literature. Scholars and practitioners have responded differently in their thinking on how to achieve the goals of mathematics education in high school

math classrooms within the context of the difficult transition year for Grade 9 students. These responses are categorized below into four broad themes.

Part III- Changing Mathematics Teaching to Achieve the Goals of Mathematics Education

The NCTM (2014) describes seven mathematics teaching practices to strengthen the learning of mathematics. It is written from the context of what the teacher should be doing to facilitate meaningful mathematics learning. *The Manitoba Curriculum Framework of Outcomes for Grades 9-12 Mathematics* (2014) provides a list of seven processes that they state are critical aspects of learning, doing, and understanding mathematics. This is written from the student perspective; or what the student's role looks like when participating in mathematics learning. In Table 2, we notice some overlaps between the teaching and learning of mathematics as seen by the NCTM and the province of Manitoba.

Table 2: Connecting the NCTM and provincial processes of learning and understanding mathematics to the literature

Broader Themes	NCTM 7 Mathematics Teaching Practices	Province of Manitoba 7 Critical Aspects of Learning, Doing, and Understanding Mathematics
Theme I- The occurrence and frequency of rich mathematical tasks that promote problem-solving and critical-thinking	Implement tasks that promote reasoning and problem solving	Develop and apply new mathematical knowledge through problem solving
	Pose purposeful questions	Use communication in order to learn and express their understanding
	Build procedural fluency from conceptual understanding	Demonstrate fluency with mental mathematics and estimation

		Develop visualization skills to assist in processing information, making connections, and solving problems
Theme II- The facilitation of meaningful mathematical discussion, communication, collaboration, and discourse as a way to a) deepen mathematical understanding and b) promote equity and social responsibility	Facilitate meaningful mathematical discourse	Develop mathematical reasoning
Theme III- Supporting productive struggle and risk-taking when learning mathematics	Support productive struggle in learning mathematics	Make connections among mathematical ideas, other concepts in mathematics, everyday experiences, and other disciplines
Theme IV- Purposeful and effective integration of technology into the math classroom	Use and connect mathematical representations	Select and use technology as a tool for learning and solving problems
	Elicit and use evidence of student thinking	

These four themes resulted from my review of the mathematics teaching and learning processes from both the national and provincial documents, and my review of the literature. I will now explore these themes in greater detail.

Theme I- The occurrence and frequency of rich mathematical tasks that promote problem-solving and critical-thinking.

The Manitoba mathematics curriculum (2014) asserts:

…learning through problem solving should be the focus of mathematics at all grade levels. Students develop a true understanding of mathematical concepts and procedures

> when they solve problems in meaningful contexts... problem solving is to be employed throughout all of mathematics and should be embedded throughout all topics (p.10).

The NCTM (2014) asserts that teachers must offer students an opportunity to explore and solve problems by posing tasks on a regular basis that require a high level of cognitive demand from the students (p. 24).

It is worth noting that the literature on this subject also supports the notion of frequent and purposeful implementation of tasks that require problem-solving and critical-thinking from students in a high school mathematics classroom. For example, in an analysis of mathematical tasks used in what they refer to as 'reform' classrooms, Stein, Grover, and Henningsen (1996), found "consistent recommendations for the exposure of students to meaningful and worthwhile mathematical tasks, tasks that are truly problematic for students" (p. 456). They characterized these tasks as ones in which students needed to impose meaning and structure, make decisions about what to do, and decide on the reasonableness of their actions and solutions. In addition, they defined these problem-solving tasks as ones that have features such as having more than one solution strategy and being able to be represented in multiple ways.

The Manitoba mathematics curriculum also reminds teachers of effective problem-solving and asserts that if students have already been given ways to solve a problem, it is not problem-solving but, instead, it is practice. They state, "true problems require students to use prior knowledge in new ways and contexts… problems are tasks that are rich and open-ended, so there may be more than one way of arriving at a solution or there may be multiple answers" (p.10). I believe that this response of creating a classroom environment that encourages meaningful problem solving is an effective way to reach the NCTM's goals of developing strategic competence and adaptive reasoning in students. In addition, an environment that

encourages problem solving in mathematics helps reach the provincial goals of helping students to communicate and reason mathematically and to make connections between their mathematical knowledge and skills and their applications.

As Boaler (2016) describes, “great mathematics tasks are a wonderful resource… they can make the difference between happy, inspired students and disengaged, unmotivated students. The tasks and questions used help develop mathematical mindsets and create the conditions for deep, connected understanding” (p. 57). The use of these rich mathematical tasks that encourage problem solving promotes the goals set out by the province and the NCTM. Liljedahl (2016) coined this idea as Building Thinking Classrooms (p. 1). Liljedahl (2016) offers his readers insights based on his research. He says that it is motivated by what he perceives as something that is missing from many mathematics classrooms, namely, a central focus on thinking.

> The realization that (a central focus on thinking) was absent in so many classrooms that I visited motivated me to find a way to build, within these same classrooms, a culture of thinking, both for the student and the teachers. I wanted to build, what I now call, a thinking classroom – a classroom that is not only conducive to thinking but also occasions thinking, a space that is inhabited by thinking individuals as well as individuals thinking collectively, learning together, and constructing knowledge and understanding through activity and discussion (p. 2).

Liljedahl (2016) goes on to describe a set of nine teaching practices that are conducive to the building, or maintenance, of a thinking classroom. Centered around problem-solving and critical thinking, those teaching practices focus on the overarching goal of finding better ways to create a thinking classroom. “By constructing a thinking classroom,” Liljedahl noted, “problem solving

becomes not only a means, but also an end. A thinking classroom is shot through with rich problems… it creates a classroom conducive to the collaborative solving of problems" (p. 25).

Theme II- The facilitation of meaningful mathematical discussion, communication, collaboration, and discourse.

The literature highlights two important benefits of providing opportunities for mathematical discussion, communication and collaboration in the classroom. The first, and perhaps the more obvious, is to deepen mathematical understanding. However, the second and perhaps more overlooked advantage, and in my opinion the most important, is how it promotes equity and social responsibility among students who participate in mathematical conversations. Each of these facets of promoting meaningful conversations in mathematics classrooms will be explored below.

Theme II (a) Discussion, communication, collaboration and discourse as a way to deepen mathematical understanding.

Mathematical discussions are a key part of current visions of effective mathematics teaching (Stein, Engle, Smith & Hughes, 2008). These authors assert that students, once presented with mathematical problems, will use each other as resources for working through problems, and then share their strategies and solutions with the larger class and teacher. This mathematical discourse in the classroom includes the purposeful exchange of ideas through classroom discussion, and gives students opportunities to share ideas, clarify understandings, construct convincing arguments regarding why and how things work, develop a language for expressing mathematical ideas, and learn to see things from other perspectives (NCTM, 2014, p. 29).

Many studies have demonstrated that discussion and collaboration through small group learning have a positive impact on student learning in mathematics. For example, Sofroniou and Poutos (2016) investigated the effectiveness of small group learning with first-year civil engineering students during their mathematics module. The researchers conducted small group learning sessions over four weeks, and then asked students to complete evaluation surveys about their perception of the effectiveness of this learning methodology. When reading the students' evaluations, the researchers deduced that, in general, students perceived mathematics as a difficult, challenging and yet rewarding subject, with all students agreeing that their small group learning experience in the mathematics module had been helpful and enjoyable. In addition, students believed that learning in groups positively affected the way they learn mathematics and allowed them to develop their critical thinking and analytical skills. Students acknowledged that this type of learning environment allowed for collaboration with their classmates, and it strengthened their confidence in the subject (Sofroniou & Poutos, 2016, p. 7).

In another study done by Mulryan (1994), five sixth-grade mathematics classes were chosen to investigate the effects of working in cooperative small groups. Student and teacher interviews were conducted at the beginning and end of the study and after individual lessons were observed. The interview responses demonstrated that both teachers and students saw the benefits in cooperative small-group work. Generally, both saw it as a collaborative process that involved giving and receiving help, ideas, opinions and information that aided all members of the group. Mulryan (1994) concluded that the communication and discussion that occurred in a cooperative small-group setting provided students with opportunities to engage in higher-order thinking and problem-solving in a way that is "not often possible in regular mathematics lessons" (Mulryan, p. 289).

The Manitoba mathematics curriculum (2014) agrees with the literature and asserts that students need opportunities to communicate about mathematics in the classroom in a variety of ways and contexts, and that these conversations around mathematics are important in clarifying, reinforcing, and modifying ideas, attitudes, and beliefs about mathematics (p. 8). I believe that giving students opportunities to collaborate, communicate, engage in mathematical discussion and discourse, made more accessible by providing opportunities for small group learning, serves to deepen their mathematical understanding.

Theme II (b) Discussion, communication, collaboration and discourse as a way to promote equity and social responsibility.

Another theme reflected in the literature is that small group learning promotes equity and social responsibility among students in the classroom. This concept is exemplified in the aforementioned study by Mulryan (1994) when she discusses the responses of students when asked about the purpose of cooperative small-group work. In their responses, students referred to the learning of social skills not specifically related to the actual learning task when they worked in cooperative groups. For example, students acknowledge that when working in groups, they learned from each other, helped each other, learned to work with others, got to know each other, and learned to get along with people (p. 283).

Boaler (2016) also demonstrated this concept in a four-year National Science Foundation research project in which she contrasted different approaches to mathematics teaching to understand how students find success in mathematics under different types of instruction. One important aspect of this project was teaching students to be responsible for each other's learning through working in small groups and collaboration. Boaler (2016) describes how this sense of social responsibility was apparent in her study.

> The students also developed broader perceptions of the value of different students, and they began to realize that all students could offer something to the solving of problems. As the approach they experienced became more multidimensional, they came to regard each other in more multidimensional ways, valuing the different ways of seeing and understanding mathematics that different students brought to problem (p. 138).

Furthermore, Boaler (2016) notes:

> It would be hard to spend [time in these] classrooms… without noticing that students were learning to treat each other in more respectful ways than is typically seen… [and] as students worked in math, they were taught to appreciate the contributions of different students… and that students learned something extremely important through this process– something that would serve them and others well in their future interactions in society (p. 139).

I believe that mathematical discourse provides important opportunities for students to learn from each other and about each other. Specifically, students get the chance to learn and improve how to respectfully listen to, talk with, respond to, and question each other while still respecting and valuing each other's opinions and ideas. In my opinion, these communication skills are critical in learning how to be a considerate and contributing member of society.

Theme III- Supporting productive struggle and risk-taking when learning mathematics.

The Manitoba mathematics curriculum (2014) suggests that creating a classroom environment where students openly engage in finding a variety of strategies for solving problems empowers them to be cognitive mathematical risk-takers (p. 11). The authors of NCTM (2014) also suggest that effective mathematics teaching supports students in struggling productively as

they learn concepts in mathematics. “Effective teaching of mathematics,” they noted, “consistently provides students, individually and collectively, with opportunities and supports to engage in productive struggle as they grapple with mathematical ideas and relationships” (p. 48).

When I refer to productive struggle, I am referring to offering students opportunities to learn more deeply about mathematics concepts and focus on the relationships between mathematical ideas, as opposed to simply seeking correct solutions. This may appear at first as students not having enough information to solve a problem, but I believe that this type of struggle and risk-taking in mathematics is key in having them make sense of the concepts and proceeding with a plan to solve a problem. In my experience, teachers sometimes perceive student frustration or lack of immediate success as an indicator that we have failed our students and have not taught them correctly. As teachers, we sometimes rush to jump in and, as I describe it, rescue students by guiding them step-by-step through difficult problems. Even though teachers might be well-intentioned in doing this, and students perceive this as teaching them, this in fact undermines the efforts of the students and deprives students of opportunities to fully engage in making sense and meaning of the mathematics (Reinhart, 2000; NCTM, 2014).

Scholars and practitioners within mathematics education also point out that a focus on productive student struggle is a necessary component of teaching that supports students’ learning and understanding of mathematics. This type of teaching which encourages and embraces productive struggle leads to long-term benefits such as students being able to apply their learning to new problem situations (Hiebert & Grouws, 2007; Kapur 2010; NCTM, 2014).

Boaler (2016) discusses the role and importance of making mistakes as a part of productive struggle. “If we believe that we can learn, and that mistakes are valuable, our brains grow to a greater extent when we make a mistake” (p. 13). She continued to say that this “result

is highly significant," because it reveals "how important it is that all students believe in themselves, particularly when (they) approach something challenging" (p. 13).

As teachers we have a choice. To approach mathematical problems from the perspective of providing the right answers is to cheat ourselves into believing that success is defined only in terms of being right or wrong. On the other hand, to construct conditions where students can struggle by stretching their thinking would essentially mean that we, as teachers, enable them to learn through their mistakes. Teachers, in other words, could choose to create an environment where mistakes are not frowned upon. Mistakes could become a constructive part of productive struggle with the goal of helping students stretch their thinking and learning. In this way, teachers are not only preparing their students to simply solve mathematical problems but also preparing them for life.

Theme IV- Purposeful and effective integration of technology into the math classroom.

The final theme that I hope to shed some light on is what I have termed the purposeful and effective integration of technology into the mathematics classroom. As the authors of the NCTM (2014) note, "An excellent mathematics program integrates the use of mathematical tools and technology as essential resources to help students learn and make sense of mathematical ideas, reason mathematically, and communicate their mathematical thinking" (p. 5). The Manitoba mathematics curriculum (2014) also highlights the importance of using technology effectively to contribute to and support the learning of a wide range of mathematical learning outcomes. While there are many approaches to integrating technology into the classroom, I would suggest that we, as teachers, would also need to engage in the purposeful use of technology.

As discussed in Chapter 1, my own journey with integrating technology into my mathematics classes in a purposeful way reflected two alternative teaching designs; creating a flipped and later blended classroom. I experimented with these two alternate teaching methodologies because I believed that perhaps the aforementioned goals of mathematics education would be better attained by using these alternate teaching designs.

One of my own struggles with my ninth-grade classes is directly related to the pacing of the course. For some students, the pace is too slow and for others, much too fast. While the flipped and blended learning environments provide the means for students to be able to work at their own pace and self-regulate their learning, my experience suggests that I may have to construct different levels of difficulty, and pace them accordingly. The research on flipped or blended classroom designs affirms that students are better able to self-regulate and pace their own learning. Bergmann and Sams (2012), for example, offer a description of learning in a flipped classroom when they say,

> …students are working on different activities at different times. Students are busy and engaged in their learning. You would see some students conducting experiments or other inquiry activities, some watching videos on their personal devices, some working in groups mastering objectives, some interacting with the white-board to engage with online simulations, some studying in small groups, and some taking assessments. You would also see some working one-on-one in a small group or with the teacher. (p. 53)

Bergmann and Sams (2012) also describe how students take more responsibility for their own learning in the flipped classroom, and how the onus for learning is placed on the students.

> Some students are being asked for the first time to take ownership of their education. Learning is no longer an imposition on their freedom but rather a challenge to be

> unpacked and explored. As the teacher gives up control of the learning process, the students take the reins, and the educational process becomes their own. (p. 60)

As I mentioned in Chapter 1, I am looking for ways to purposefully integrate technology in ways that allow students to access content on their own without it being teacher-centered. To this end, I have been using the online Desmos activities and graphing calculator to enhance and increase students' understanding of mathematics. I believe that, at this point in time, Desmos is a technology that is better aligned with the goals of technology in mathematics education as described by the Manitoba mathematics curriculum (2014).

> Technology has the potential to enhance the teaching and learning of mathematics. It can be used to explore and demonstrate mathematical relationships and patterns, organize and display data, generate and test inductive conjectures, extrapolate and interpolate… (and) increase the focus on conceptual understanding by decreasing the time spent on repetitive procedures. (p. 11)

In my experience I have found that, as an educational tool, Desmos better serves to enhance the conceptual understanding, procedural thinking, and problem-solving capabilities of my students in my mathematics classroom.

Bourassa (2016) affirms that "Desmos is an educational technology company that never stops innovating… the activities they have developed have strong pedagogy in addition to being engaging and fun for students to complete" (p. 8). In addition to the student activities, Desmos' free online graphing calculator can do most of the same functions as a hand-held graphing calculator, with the most obvious advantage being that it's functionality is intuitive, the screen is large and it is much faster at graphing. This allows the opportunity for students to have immediate feedback, and students are able to see the function that they are graphing change in

real-time as they modify parameters, which helps give them a visual representation of the concepts.

King (2017) completed a study in which students were asked to create an artistic drawing with Desmos, using different functions and their transformations. King noted that the instant feedback provided through Desmos enabled students to engage differently and it made the experience more enjoyable because students were able to explore what happens to the graph of functions as the parameters vary, in real-time. Teachers in this study said that it was encouraging to see their students gain a deeper comprehension of the mathematics behind transformations because of how the technology made something so theoretical become so visual (p. 34). King (2017) acknowledged that the students' positive responses, constructive attitudes, and evidence of completing the activity, led her to conclude that these types of activities, made possible by technologies such as Desmos, were valuable because they provided a deeper conceptual understanding of the mathematics' concepts (p. 37). In addition, other areas of the student experience included "higher student engagement in terms of discovery and exploration; promotion of higher-level thinking skills; and improvement in students' visualization skills" (King, 2017, p. 37).

In my experience, technology has been a positive contribution to the efforts of changing mathematics education for students. I do want to reiterate that I am not exclusively for or against any one type of technology-assisted teaching design, such as flipped or blended classrooms, or teaching and learning resource, such as Desmos. When looking at integrating technology into the mathematics classroom, I am concerned about how any technology can substantially change the way that students are able to understand mathematical concepts.

Moving from the theoretical foundations to my action plan

As I move to Chapter 3, I hope to use the four themes as found in the literature as a framework for collecting and interpreting my data. These four themes are focal points that I will turn to in conversation, and they will form the foundation on which I rest to analyze my data. I seek to engage Grade 9 Mathematics teachers in conversation in the hopes that I can uncover the different methods used by my colleagues in enabling success for all Grade 9 Mathematics students. I hope to learn about how their methods and processes align with the goals of both the NCTM (2014) and the Manitoba mathematics curriculum (2014). It is with this intent that I now turn to Chapter 3, Methodology.

In moving forward to Chapters 3 and 4 of my thesis, it might be useful to readers to know that Chapter 3 is preserved as it was in my research proposal, to serve as a record of the research journey as planned. Chapter 4 will describe the research plan as it came to be enacted, including adaptations from selecting and recruiting teacher research participants, on to data gathering through interviews and classroom observations, and into interpretation.

Chapter 3- Methodology

The aim of this chapter is to clarify the purpose of my research study and outline my data collection, analysis, and interpretation processes. This chapter is divided into four parts. Part I will offer a general overview of how I plan to address my research focus. This includes the purpose and focus of this research project as well as a brief description of the collection, processing, analysis, and interpretation of data. Part II of this chapter will focus on the methodological features of my research study. This section will be subcategorized into three parts: (a) the conceptual approach through the lens of phenomenology, (b) data collection by means of interviews and classroom observations, and member checks, and (c) data analysis and interpretation. Part III will offer a proposed chronological process for collecting, analyzing, and interpreting my data. Finally, Part IV of this chapter will offer a structural timeline to complete this research project.

Part I: General Overview

Purpose.

The purpose of this research project is to gain an in-depth understanding of the experiences of Grade 9 Mathematics teachers to better understand their role in enabling student success. This will provide insight into the different teaching methodologies and strategies that might be used in Grade 9 Mathematics classrooms to better create conditions for student success.

Within the context of this study, I define success as the inclusion of opportunities for students to accomplish the goals as defined by both the NCTM and the Manitoba mathematics curriculum. Consequently, I am interested in discovering in what ways my purposive sample of teacher research participants align their teaching methods with the goals of the NCTM and the

Manitoba mathematics curriculum, and what other priorities and goals are teachers trying to accomplish with their students?

Data gathering and processing.

I will be conducting a qualitative research study through interviews with a purposeful sample of teacher research participants, classroom observations, and "member-checks." Guba and Lincoln, for example, described member checks as "systematically soliciting feedback about one's data and conclusions from the people you are studying" (as cited in Maxwell, 1996, p. 94). To this end, I will follow-up my interviews and classroom observations by re-engaging the participants to rule out the possibility of misinterpreting the meaning of what they said, to offer participants an opportunity to further clarify both what they said and did in their respective classrooms, and to ask them any further follow-up questions I may have after the initial analysis and interpretation of the data. In addition, the member check process will provide an opportunity for my purposive sample of teacher research participants to offer more insight to the explanatory factors that underlie the decisions they've made in their classroom to better enable student success.

Maxwell (1996) defined purposive sampling as a "strategy in which particular settings, persons, or events are selected deliberately in order to provide important information that can't be gotten as well from other choices" (Maxwell, 1996, p. 70). This research process will include choosing a purposeful sample of Grade 9 Mathematics teachers who have been provided with more time to teach the one credit Grade 9 Mathematics course. In speaking with and observing them, I hope to gain insight into the three questions that are guiding my central research question; namely:

1. What are the non-traditional teaching methods and strategies being used by my purposeful sample of Grade 9 Mathematics teachers?
2. How are these non-traditional teaching methods and strategies aligned with their own goals and the goals of mathematics education as defined by the NCTM and the Manitoba mathematics curriculum?
3. What explanatory factors underlie the positioning's of these teachers whose total time for the course allows them to adapt, change, or reform their instructional methods?

Data analysis and interpretation.

I will follow the suggestions of both Maxwell (1996) and LeCompte (2000) in analyzing and interpreting the data gathered in this study. While I will address this in detail further in this chapter, it suffices to note what both Maxwell and LeCompte share in their method for data analysis. For Maxwell (1996), one of the most successful methods when analyzing qualitative data is through the art of "categorizing strategies," such as coding and thematic analysis (p. 78). LeCompte (2000) offered a more detailed description on how to approach the task of data analysis. She suggested that researchers must first determine how they want to organize their data. Structurally, I propose to interpret and organize my data through a thematic analysis by referring to the four themes as reflected in the literature, and the goals of mathematics education as defined by the NCTM and the Manitoba mathematics curriculum. These themes and goals will be re-identified in greater detail in Part III.

Part II: Methodological Features

Methodology: A Phenomenological Approach.

My qualitative research project stresses a phenomenological model of data analysis and interpretation. To paraphrase McMillan (2008), the purpose of conducting a phenomenological study is to understand, describe, and interpret the experiences of participants to understand the 'essence' of their experiences. It is, in other words, to arrive at a description of a particular phenomenon (Creswell, 2013, p. 77). According to Bruyn (1996), phenomenology, as a qualitative tradition of inquiry, has conventionally served "as the rationale behind efforts to understand individuals by entering into their field of perception in order to see life as these individuals see it" (p. 90). Within the context of this proposed research, the phenomenon under investigation is how my teacher research participants experience their role in enabling success for all students in Grade 9 Mathematics.

Phenomenology as an approach to understanding has a very rich tradition in the field of social sciences and humanities. For example, some of these different phenomenological orientations include, descriptive phenomenology (Giorgi, 2009), interpretive-hermeneutic phenomenology (Holroyd, 2007), transcendental phenomenology (Husserl, 1997), social phenomenology (Schutz, 1932/1967), psychological phenomenology (Moustakas, 1994), and empirical phenomenological research (Moustakas, 1994). I propose to focus on one specific phenomenological approach, namely, "empirical phenomenological research" (Moustakas, 1994, p. 11). This approach "involves a return to experience in order to obtain comprehensive descriptions that provide the basis for reflective structural analysis that portrays the essences of the experience" (p. 13). Practically, I will return to the experience of the participants to obtain a comprehensive description of their methods of teaching as a basis for my reflective analysis.

Methods.

Three qualitative data collection techniques will be used to better understand what is currently occurring in Grade 9 Mathematics classrooms in Manitoba. These will include face-to-face interviews, classroom observations, and member checks.

Selection of participants.

My plan is to interview four to six teachers in various school divisions in Manitoba who have been provided with more time to teach Grade 9 Mathematics. While my purposeful sample may be small, I realize that I will be drawing a substantial amount of rich data from each teacher research participant. Becker (1970) and Maxwell (1996), for example, suggest that rich data are detailed and complete enough to provide a full and revealing picture of what is going on. Some qualitative researchers refer to this sort of data as thick description (Ryle, 1949) when it is applied to ethnographic research (Gertz (1973). At the same time, I am confident that the information gained from this study will be both timely and meaningful.

As with any type of research, I am faced with a decision about the selection of research participants. It is beyond the scope of this study to engage with every Grade 9 Mathematics teacher in Manitoba who has changed or reformed their approach to teaching. I believe that I will be more likely to find teachers who have reformed their teaching in situations where they have been provided with more time to teach the course, which is the scope of this study. In engaging with these teachers, I am interested in the (a) range of non-traditional approaches and teaching methods they are using to reform the way they teach Grade 9 Mathematics, (b) the goals they are trying to achieve by initiating this teaching reform, and (c) what explanatory factors underlie their positions and decisions to change their teaching methods.

Interviews.

I propose to conduct face-to-face interviews with four to six teachers in Winnipeg, Manitoba, who have more time in their schedule to teach Grade 9 Mathematics. Weiss (1994) described this type of qualitative interview process as not using samples but rather *panels,* which he defined as "people who are uniquely able to be informative because they are expert in an area or were privileged witnesses to an event" (p. 17). Maxwell (1996) echoed this sentiment when he described panels, as "one form of purposeful sampling" (p. 70). In this study, I will invite Grade 9 Mathematics teachers who (a) have been provided with more time to teach this course, and (b) who are particularly engaged and invested in the phenomenon being studied, to provide their insights and understandings about the teaching and learning opportunities for their Grade 9 Mathematics students with a view to enable success for all students.

Some critics of panel interviews suggest that the qualities that make panels valuable would also make them unrepresentative of the larger group of all Grade 9 Mathematics teachers in Manitoba (McMillan, 2008). Maxwell (1996) also recognized that qualitative researchers who "rely on a small number of informants for a major part of their data," and "even when these informants are purposefully selected… there is no guarantee that these informants' views are typical" (p. 73). From the perspective of qualitative research, my aim, however, is *not* to achieve representativeness, but rather to learn from a few focused teacher research participants to better understand the phenomenon under investigation. While there is no guarantee that their views will be necessarily typical of the larger population of Grade 9 Mathematics teachers, I believe that there is rich data to be gained. I am most interested in the narratives of my participants; I want to learn from their stories and experiences within the range of contexts that they work in. I believe that their perspectives and experiences will offer rich data in terms of the range of approaches

and teaching methods being used, and I am interested in uncovering how their goals and their teaching methods are aimed at improving student success in Grade 9 Mathematics, what goals they are trying to achieve by using these teaching methods, and how they experience their role in enabling success with their students.

Prior to my face-to-face-audio-taped interviews, I will provide the teacher research participants with the interview purpose and the proposed questions ahead of time. This will help to provide background context to the purpose of the interview. For example, some questions might include:

i. How are you using the extra time afforded to teaching Grade 9 Mathematics?

ii. How might you describe your teaching methods?

iii. What do you see as benefits or obstacles to the allotment of extra time for math education?

iv. How have your students received the allotment of the extra time for math education?

v. Have you taught Grade 9 Mathematics without the structural change in timetable? If yes, I will ask: Compared to teaching this course without the structural change, what has been your experience in teaching this course *with* the structural change? If no, then I will simply ask: What has been your experience in teaching this course?

vi. Can you describe one or more *new* teaching methods or approaches that you have implemented with your students or are currently implementing?

vii. How do you define success in your classroom? How do you view your role in terms of enabling success in your classroom?

My interviews will be semi-structured. This will allow me to focus on the phenomena being studied while at the same time providing opportunities for the teachers to speak openly and

informally within the context of pre-determined questions. Practically, this will include asking probing questions in response to what I receive.

I acknowledge that using qualitative interviews as an approach to data collection presents an opportunity and a risk. While the opportunity lends itself to gathering the data to help me and others understand the phenomenon under investigation, I cannot guarantee or control for what teachers will choose to share with me. I enter into this study with the belief that my teacher research participants will be willing to honestly communicate their experiences with me. At the same time, I accept that part of this experience will include the subjectivity and partiality of both me, as researcher, and my research participants. For example, in interviewing my participants, I am aware that I can unintentionally influence teacher research participants not only with leading questions but also with my non-verbal behaviors like nodding, raising of my eye-brows, with grunts like 'ah huh,' or with a comment like 'oh really?' While these cannot be avoided, I will be more mindful of these types of behaviors in my interview process. At best, I will probe for better understanding and clarification.

While impartiality necessitates, according to Tremblay (1979), that teacher research participants should be objective and unbiased, and that any relevant biases will be made known to the interviewer, it is simply not possible to negate subjectivity in any natural setting. Whereas the positivism of science would call on researchers to mind their subjectivity, as if subjectivity is a sin to be avoided, this qualitative research calls, as Maxwell (1996) noted, to mine the subjectivity of research participants and the researcher, because there is a wealth of information and knowledge that is waiting to be mined. What is significant for this research is to not only see how teachers accomplish the goals and outcomes that they deem as important, but to also engage in their subjectivities and experiences.

Classroom observations.

I will also ask the teachers for the opportunity to observe a lesson of their choice in their Grade 9 Mathematics classroom. The purpose of the classroom observation is threefold:

- Connect their interview comments with what they do in class;
- Provide a context for what the teachers do in their classroom and their 'spur of the moment' actions in response to student inquiry and behaviors; and
- Further inform myself on the teaching methods and processes that Grade 9 Mathematics teachers are using in their classrooms to enable students' success.

During the classroom observations, the role I will play will be that of an observer. McMillan (2008) defines this role as one who does not take on the role of participant (p. 278). However, he cautions that the mere presence of an observer, whether involved or detached, may still affect the behavior and responses of those observed (p. 279). While I am observing each of the classrooms and the teacher-implemented activities, I will be taking detailed field notes on the actions and behaviors of the teacher. These notes will be centered around the chosen activities of the teachers within the context of their classroom experience, and not of the students and their behaviors. According to McMillan (2008),

> …field notes are detailed written descriptions of what was observed, as well as the researcher's interpretations…they constitute the raw data that the researcher analyzes to address the research problem. The assumption is that nothing is trivial, so whatever is seen, heard, or experienced is recorded and considered. (p. 279)

My descriptions might include words, pictures, drawings, maps, and diagrams so that I can best capture the details of what is occurring in the classroom. My observations will be unstructured in that I will have no predetermined categories or checklists. To reiterate, my notes will be focused

on the actions, decisions, priorities and teaching of the teacher. To this end, I aim to describe the following in detail:

i. A description of the classroom setting, such as how the desks in the classroom are organized and what is featured on the bulletin boards;

ii. The types of activity that the teacher has chosen;

iii. How the teacher has structured the pacing of different activities;

iv. What the teacher does in response to students' questions and behavior.

While my field notes may assist in my coding and thematic analysis of data, I will also engage in a process of what Maxwell (1996) described as the writing of 'memos.' Memos can range from marginal comments or a theoretical idea recorded in a field journal, as a way of facilitating reflection and analytic insight (p. 11). For Maxwell, memos are valuable in that they offer the researcher an opportunity to "engage in serious reflection and self-critique rather than just mechanically recording events and thoughts" (p. 12).

Soon after the classroom observations, I will expand on both my field notes and memos as a way of structuring the analysis of my observations. This process will enable me to include my own reflections. These could include my speculations, feelings, interpretations, ideas, and impressions of what is happening in a particular Grade 9 Mathematics classroom. These reflections will be subjective, and I hope to mine my subjectivity in my analysis. Consequently, this approach will violate the call for social science researchers to "set aside all pre-judgments," and "to bracket his or her own experiences in order to understand those of the participants in the study" (Creswell, 1997, p. 52). Bruner (1986), however, argued that no social scientist "is truly innocent" and that "all (social scientists) begin with a narrative in (their) heads which structures (their) initial observations in the field" (p. 186). Consequently, my analysis will be

intersubjective in that I will interpret the experience of my purposive sample and at the same time also be a part of the experience.

Member checks.

After my initial analysis and interpretation of data gathered, I will seek feedback from each teacher. One sort of feedback is member checks. The purpose of completing member checks is to provide an opportunity for teachers in this study to provide feedback on my interpretation of the information gained through interviews and classroom observation and to offer further insight into their experience. According to Maxwell (1996), member checks are one of the most important ways of ruling out the possibility of misinterpreting what the teacher research participants have said or done, and this gives them an opportunity to validate my interpretation or offer another perspective. At the same time, I aim to use member checks as an opportunity to ask follow-up questions to further clarify and understand their observed actions and reactions. For example, if a teacher showed a higher preference for the use of one teaching method such as the integration of Desmos technology, I aim to seek their understanding of their preference and their rationale behind their decisions. Finally, I hope to use member checks as an opportunity to ask teachers to connect what they said in their initial interview to what occurred in the classroom observation.

By completing member checks in this way, I aim to focus more on *why* teachers are doing what they are doing, and their perceived role and experiences in enabling success for their students. Here is another example: If a teacher had expressed the need to build student confidence in their interviews as a condition of students' success, I also aim to connect what they said (interviews) to what was observed (classroom observation) by asking: "What aspects of

your classroom activities helped students build confidence?" Audio-taped information gained through member-checks will allow me to update my initial analysis and interpretation of data.

Data analysis and interpretation.

I will follow the suggestions of Maxwell (1996) and LeCompte (2000) in analyzing and interpreting the information that I receive from both interviews and classroom observations. Maxwell (1996) noted that one of the most successful methods to analyze qualitative data is that of categorizing strategies, through coding and thematic analysis (p. 78). He defined the goal of coding as breaking down the data in order to "rearrange it into categories in order to facilitate the comparison of this data within and between these categories" (p. 78). He suggests that coding is the precursor to thematic analysis, which is the development of theoretical concepts that will help organize the data into broader themes and issues. I will code information gathered in both my interviews and classroom observations in ways that are aligned with the four themes as found in the literature and the goals of mathematics education as defined by the NCTM and the Manitoba mathematics curriculum, as outlined in Chapter 2.

Aligning the coding of items in ways that are aligned with the four themes and goals of mathematics education is compatible and consistent with LeCompte's (2000) approach to data analysis and interpretation. She suggested that researchers must determine how they want to organize their data. I propose to organize my data around the four themes as defined above and the goals of mathematics education as defined by the NCTM and the Manitoba mathematics curriculum. Once the organizational structure has been decided, LeCompte (2000) suggested that researchers must use this structure to (a) construct an intact picture of the phenomenon under study and (b) tell readers what the picture means (p. 146). This is precisely what I propose to do.

The construction of an intact picture will be reflected in my analysis of the data. Telling readers what this picture means will be reflected in my interpretation of the data.

While LeCompte (2000) approaches qualitative research and data analysis inductively, namely from the bottom up, where items are connected to previously undefined themes, my proposed study is deductive in nature. I am interested in examining how the activities, teaching methods, and teachers' decisions align with both the four themes as reflected in the literature and the goals of mathematics education as defined by the NCTM and the Manitoba mathematics curriculum. This deductive process relates to two of the five steps that LeCompte proposed for data analysis and interpretation.

The first step that LeCompte identified is what she called 'tidying up'. She asserted that tidying up is an "absolutely necessary first step to coding and analyzing data" (LeCompte, 2000, p. 148). While she listed some managerial things such as making copies of data and filing field notes according to date, LeCompte reminded us that one important part of tidying up is to review the initial research questions and compare them against the data collected. This initial step of 'tidying up' will help me make a preliminary assessment of my data in relation to my research questions.

The second step is the process of 'finding items.' She defines 'items' as the specific units of analysis in the data set that researchers code and assemble into research results (LeCompte, 2000, p. 148). Finding these items will involve the systematic process of looking at the ideas that are brought forward, the omission of certain ideas, and the declaration of statements or ideas by the interviewees.

In relation to this proposed study and as reflected in Table 3 below, the organization of items that may, for example, be discovered in classroom observation will (a) be connected to one

or several of the four themes as provided in Table 2 (Chapter 2), and (b) further connected to the goals of both the NCTM and the Province of Manitoba, as provided in Table 1 (Chapter 2). These connections will lead help me (c) identify themes among the explanatory factors that underlie the teachers' decisions and experiences. I am unsure which themes will emerge from this study, so this last part of my analysis is not yet included in my table.

Table 3: Proposed Coding, Analysis and Interpretation of Data

Example of Possible Items	Themes	NCTM Goals	Province of Manitoba Goals
Teachers' use of vertical whiteboard work in small groups.	The facilitation of meaningful mathematical discussion, communication, and discourse.	*Strategic Competence:* this is described as the student's ability to formulate, represent, and solve mathematical problems.	Communicate and reason mathematically Use mathematics confidently, accurately, and efficiently to solve problems.
Teachers' use of Desmos activities on laptops.	The occurrence and frequency of mathematical tasks that promote problem-solving and critical-thinking.	*Conceptual understanding:* the comprehension and connections of different concepts, operations, and relations in mathematics.	Make connections between mathematical knowledge and skills and their applications
	The purposeful integration of technology into the mathematics classroom.	*Adaptive Reasoning:* the student's ability to think logically and justify their thinking.	

In summary, Part II was subcategorized into three parts: (a) conceptual approach to the proposed study through the lens of phenomenology, (b) data collection by means of interviews, classroom observations, and member checks, and (c) data analysis and interpretation. I will now discuss the chronological process for this proposed study.

Part III: Proposed Chronological Process

In this section I will provide a detailed description of the chronological process I will follow when completing the data collection, analysis, and interpretation of this proposed research project.

Selecting teacher research participants.

To find and choose four to six teacher research participants to interview, I will first speak with leaders in mathematics education in Manitoba. I will contact two professors in Mathematics Education - Dr. Ralph Mason and Dr. Martha Koch- at the University of Manitoba, and Ian Donnelly, who is the Senior Years consultant for Manitoba Mathematics Education, to both share my research project and ask for names of possible teacher research participants. In speaking with these three leaders in mathematics education in Manitoba, and in addition to my own network of colleagues of mathematics teachers in Winnipeg, I hope to find an appropriate sample of Grade 9 Mathematics teachers who are particularly focused in enabling success in ninth-grade students in the field of mathematics, in schools where teachers have been provided with more time to teach this course.

Letters of invitation.

Upon the reception of possible names, I will email them with a letter explaining my research, informing them of my intentions, and inviting them to participate in this research project. For those who accept the invitation, I will, along with a consent form,

i. Send them a copy of my interview questions so that they have a context for our conversation;
ii. Organize a day and time that works best for them to participate in an interview;
iii. Provide the teacher research participants with a general time frame (maximum 60 minutes) for the interview so that they are aware and prepared;

iv. Seek permission for the interview to be audio-taped;

v. Ask permission for the opportunity to observe them in their respective classrooms for one Grade 9 Mathematics class of their choice;

vi. Inform them that I will, as part of data analysis and interpretation, ask for their feedback (member checks) for the purpose of seeking their input into my preliminary findings.

Interviews.

My goal is to make the interview process as comfortable and relaxed for the teacher research participants as possible, so that they might be more willing to be open and honest in their discussions with me. I will, however, steer clear from public settings like restaurants or coffee shops as the background noise will negatively affect the listening and transcribing of the audio-recorded interviews. More importantly, it will ensure the privacy of information shared. While I will begin my interview by asking predetermined interview questions, I will also enable some degree of flexibility by asking probing or clarifying questions.

Transcription of interviews.

Upon completion of all interviews, I will transcribe the data so that I have written copies of what was said in the interviews.

Classroom Observations.

Upon completion of my transcriptions, I will ask the teacher research participants to choose a time for me to observe their classroom. Once the teacher research participant and I have decided on a time and date for the classroom observation, and prior to my observation, I will ask them to provide me with a brief and general context of the lesson that I will be observing. As described in Part II, I will take detailed field-notes of the activities of the teacher, as well as writing memos to myself. In analyzing my data, I will expand upon these field notes and memos.

Analyzing and interpreting data.

At this point, I will have two sets of data from each teacher research participant – the transcripts of my interviews and my field notes, including memos, from observing their class. I will do a preliminary analysis of my data as reflected in Table 3. The process I will follow when organizing, categorizing, analyzing, and interpreting the data will be aligned with the suggestions of both Maxwell (1996) and LeCompte (2000) as described in Part II of this chapter, and as reflected in Table 3. As previously stated, I will analyze and interpret my findings in terms of items (from interviews and classroom observations) and connect them to both the themes as reflected in the literature and the goals of the NCTM and the Manitoba mathematics curriculum (Chapter 2). At this stage, I will also make notes of other questions I may have for participants in order to further clarify and understand their interview responses and any aspect of their activities in the classroom.

Member checks.

Upon completion of my preliminary analysis and interpretation, and after I have compiled a list of follow-up questions for the teacher research participant, I will set up a date and time to complete a feedback process identified as member checks. As noted earlier, the purpose of completing member checks is to provide an opportunity for teachers in this study to provide feedback on my interpretation of the information gained through my interviews and classroom observation and to offer further insight into the explanatory factors that underlie their decisions. I will share information only as it relates to that particular teacher's interview and classroom observation. As with the initial interviews, I will ask the teachers for a time that is most convenient for them and I will audio-record our conversations and transcribe them afterwards. I will make every effort to limit my member check process to 60 minutes.

Putting it all together.

Upon completion of my member checks, I will make the necessary changes to my initial analysis and interpretation and complete Chapters 4 and 5 of my thesis. Chapter 4 will focus on Data Analysis and Data Interpretation. Chapter 5 will be titled, *Summary, Conclusions, and Recommendations*. In Chapter 5, I will focus on connecting my findings to the research questions, if appropriate, shedding some new light on the topic at hand, and making further recommendations for the future of Grade 9 mathematics education in Manitoba. In learning about this phenomenon, I hope to better inform current Grade 9 Mathematics teachers in ways that we might be able to change or improve our teaching methods so that we might help all students succeed in Grade 9 Mathematics in Manitoba.

Part IV: Timeline

The following table is a projected timeline of my data collection, analysis, and interpretation process. The timeline is subject to change depending on availability of my research participants and the length of time it will take to receive approval from the Research and Ethics Board (REB).

Table 4: Projected chronological timeline of data collection, analysis, and interpretation

Projected Date	Task
July 1-7 2018	Defend proposal.
July 8	Submit REB proposal.
September 1	Receive REB approval.
September 2-30	1. Identify potential teacher participants. 2. Contact school division ethics boards for permission. 3. Contact potential teacher participants. 4. Send consent forms and other information.

	5. Receive consent forms back from teachers. 6. Schedule interviews.
October 1-13	1. Interviews. 2. Transcription.
October 13-15	Schedule classroom observation.
October 15-31	Classroom observations.
November 1-30	1. Read transcripts, field notes and memos. 2. Preliminary analysis and interpretation. 3. Prepare follow-up questions for member checks.
December 1-7	Schedule member-check interviews.
December 8-21	Member-check interviews.
December 22-31	Finalize analysis and interpretation, including member-checks.
January 1-30 2019	Complete first draft of Chapter 4: Analyzing and Interpreting the Data.
February 1-28	1. Conversations with Dr. Mason about Chapter 4. 2. Begin Chapter 5: Summary, Conclusions, and Recommendations. 3. Edit Chapter 4.
March 1-31	1. Submit second draft of Chapter 4 to Dr. Mason. 2. Submit first draft of Chapter 5 to Dr. Mason.
April 1-30	1. Final edits to Chapter 4. 2. Conversations about Chapter 5. 3. Edit Chapter 5.
May 1-30	1. Submit second draft of Chapter 5 to Dr. Mason 2. Compile complete document. 3. Update Chapter 3.
June 1-15	Make final edits to full document.
June 16-30	Submit thesis to committee.
August 1	Approval from committee members to schedule defense.
August 1-15	1. MA Thesis Defense. 2. Final edits if necessary. 3. Submission of all documents.
October 2019	Convocation.

Chapter 4: Data Overview

Introduction

The purpose of this research project was to gain a deeper understanding of the experiences of Grade 9 Mathematics teachers to better understand their role in enabling student success. The central question that framed my research was: what are the underlying features of the experiences of Grade 9 Mathematics teachers in Manitoba who are trying to reform Grade 9 Mathematics education? Specifically, the three questions that have guided this research are:

1. What are the non-traditional teaching methods and strategies being used by a purposeful sample of Grade 9 Mathematics teachers?
2. How are these non-traditional teaching methods and strategies aligned with their own goals and goals of mathematics education as defined by the NCTM and the Manitoba mathematics curriculum?
3. What explanatory factors underlie the positioning's of these teachers whose total time for the course has allowed them to adapt, change, or reform their instructional methods?

Prior to collecting my data, my hope was to learn from a purposeful sample of teachers who might be teaching Grade 9 Mathematics in substantially different ways, with the goal of better informing myself and other teachers on how we might teach Grade 9 Mathematics to help *all* students find success.

In order to learn from these teachers, I conducted a qualitative research study through a combination of interviews with six teacher research participants, classroom observations, and a member-check process. With the permission of the school superintendents and principals, I contacted seven teachers at various schools in Manitoba. Six agreed to participate. After these interviews, I was able to observe four of them for a single lesson of their Grade 9 Mathematics

class. Through interviews and classroom observation, I gained greater insight into the different teaching methodologies and strategies that these teachers were using to better create conditions for student success in Grade 9 mathematics.

Member Checks

Immediately following these classroom observations, I followed-up with conversations with three of the teachers. Finally, I was able to complete a member-check process with five of the six teacher research participants. The member-check process included (a) providing each teacher with my description of our conversation and my observation of a single period of their Grade 9 Mathematics class, and (b) my initial analysis of what I learned. All six of the research participants were given an opportunity to comment and provide feedback on my descriptions. In their feedback, teachers affirmed the accurateness of how the descriptions of their data were represented. Some minor technical details were corrected, such as the hours per week of teaching time, or the number of hours of release time to co-plan. Because these details are logistical and did not affect my descriptions or analysis of the data, and given that I made the necessary changes, I will not refer to the member-check process when describing the data.

Chapter 4 will be organized as follows. Each section will provide a descriptive snapshot of responses from my teacher research participants based on what I learned through my interviews and classroom observations. I hope that these descriptions might offer (a) some insight and understanding of each teachers' priorities and values in their teaching, and (b) methods and strategies they used to try and reach their goals. When discussing my data sources, confidentiality is a research requirement. While I intend to present an authentic portrait of each of the six teacher research participants, for the sake of confidentiality, I will not divulge their identities. To that end, I changed the names of this purposive sample of teachers, their gender,

and the names of their schools. What will be of particular interest in this chapter is each teacher's contribution and story of how they went about the process of enabling success for all students in Grade 9 mathematics.

Data Source 1- Jack & Maria at Stonybrook School

Two teachers, Jack and Maria, work in a Grade 7-12 high school in rural Manitoba. Their school has streamed their Grade 9 students into either an 'advanced' or a 'regular' course of Grade 9 Mathematics. If students are in the regular course, they cover the Manitoba Grade 9 Mathematics curriculum. If students are in the advanced course, they cover the Manitoba Grade 9 Mathematics curriculum and are also introduced to concepts in the Grade 10 Introduction to Applied & Precalculus Mathematics course. Students are streamed into this advanced course based on demonstrating a strong mathematics understanding in Grade 8 and their Grade 8 Mathematics teacher's recommendation. As noted in Chapter 1, this practice is aligned with one of the structural changes that administrators and Manitoba school divisions have implemented, namely a new timetable structure that provides more time for students to participate in Grade 9 Mathematics. Their decision to re-examine and substantially change the way they teach this course was "strongly supported" by their administration and were granted a total of 10 days of release time during the 2018-2019 school year (5 days each) to work and plan their course together.

There are two classes of the Grade 9 Mathematics advanced course and Jack and Maria each teach one of them. Each of them had been allocated twice the amount of time to teach this course; both teachers saw their students every day for one hour for the entire school year. Even though they each had their own class of students and do not co-teach the course, Jack and Maria

decided to co-plan their Grade 9 Mathematics advanced course and teach the course in a 'non-traditional' way. It was for this reason that they suggested that I interview them together.

Their Stories

Jack shared his decision to reform the way that he was teaching his Grade 11 Precalculus class. He stated that he began his process of reform by raising the question, "What does good math learning look like?" He had written a letter to his colleagues at his high school advocating for the removal of streaming students into advanced and general programs. His proposal as he described it, "went off like a lead balloon." In addition, he said:

> I was pretty discontent with just how math was being taught in our building in general, and my teaching (was) included with that. And there were a lot of things that I guess sort of came out of that… and we've had so many, many, many discussions about how we want to teach and things that we think are important… and I think our department is slowly moving in that direction over the last year. But you know, the last two or three years (they've) definitely started to gain a lot more momentum in terms of the removal of the lecture. You know, trying to get that to be minimized; and the removal of the lecture was a big part of it.

While Jack was discontented with the practice of streaming students into advanced and general programs, and how "math was being taught…in general," he chose to do something about it. He demonstrated his leadership by writing a letter to his colleagues advocating the removal of such a practice and to rethink the lecturing-method of teaching mathematics. While his letter "went off like a lead balloon," it did initiate "many, many discussions," and eventually, change. As he noted, there has been "a lot more momentum" in the removal of the lecture method of teaching of mathematics at his school. Jack affirmed that change required the courage

to risk going against the grain of what has been accepted as standard practice. And his risk did not go unrewarded.

For example, Maria was curious about Jack's call for change and his method of teaching. She displayed her interest in what Jack was advocating for and began attending and observing Jack's Grade 11 class during her spare time. Maria admitted that she was "somebody who was extremely traditional; rows, the whole nine yards…" who "lectured, did the set of questions, provided examples… the routine…" She, somewhat sheepishly, said that: "I was very successful, in that my marks were always good, that kind of thing." However, once she started observing Jack's class, she was influenced differently. Here's what she shared:

> I remember sitting in that table and watching the students and I remember watching and thinking…you can see each kid; where each kid's brain is at, which ones need to do more, which one has mastered it, which ones are at entry, which ones are at midpoint… and you can see it all. And I'm like, that concept is really cool.

It was as if Maria was inspired by what she experienced. The ability to "see…where each kid's brain" was at, was something new for her. Maria was positively influenced by Jack's method of teaching and acknowledged that she wanted to try this new way of teaching with her Grade 9 Advanced Mathematics class and was excited to join Jack in testing an innovative way of teaching to see if it made a difference with her students' learning and understanding of the course content.

Interview Discovery

Jack and Maria each brought a unique perspective to teaching the Grade 9 Mathematics advanced course. Maria has a wealth of experience in teaching mathematics at the Grade 7 and 8 level, and Jack has been teaching in a high school mathematics classroom for his entire career.

Their individual perspectives allowed them to have both a deeper understanding of where students are *coming from* when they enter a Grade 9 Mathematics classroom, and an appreciation of where their students are *going* as they continue with mathematics in high school, regardless of their chosen pathways (Precalculus, Applied, or Essential Mathematics).

By interviewing Jack and Maria together, I was able to gain valuable insights into the shared goals they prioritized in their classrooms, and their methods and strategies. For example, they both implemented teaching strategies such as students working in small groups to solve problems on vertical non-permanent surfaces (such as whiteboards). Their purpose in doing this was to create what Liljedahl (2017) calls a "thinking classroom; one that's not only conducive to thinking but also occasions thinking, a space inhabited by thinking individuals as well as individuals thinking collectively, learning together, and constructing knowledge and understanding through activity and discussion" (p.1). This method of using vertical non-permanent surfaces to promote a thinking classroom, supported one of their priorities of having students collaborate and communicate in their mathematics classes.

In speaking with these two teachers, they affirmed that they were moving towards an environment where students were the central and active participants in their own learning. Both Jack and Maria elaborated that they were particularly committed to encouraging mathematical discourse and risk-taking in order to solve problems. As Jack summarized, he aimed to "...have kids at the whiteboards and talking math instead of it being isolated students sitting at a table with a piece of blank paper in front of them…". He appreciated "the discussions that have to happen, especially if (students) don't have an answer, so that (they're) at a table of five people and they figure it out… and they learn how to communicate with each other about what their ideas are…". Maria affirmed what Jack was doing in his classroom and noted that having

students work together to solve problems at whiteboards creates a common "mathematics-language." She noted that "it is very interesting to hear (students) when they speak mathematically together and learn the vocabulary from each other". So, not only are students active participants in their own learning, they are also co-participants in that they are offered the opportunity to learn from each other by using a common vocabulary.

My Classroom Observation

I was fortunate to observe Jack and Maria teach the same lesson to each of their respective classes. In my observations, I noticed that Maria was more structured in her outline of the lesson and gave students tactical support by writing down the plan for the class on the board. Jack, on the other hand, had a less structured approach. He provided instructions on what to do next only when the majority of the class reached a particular point in the lesson. Witnessing the subtle differences in the way Maria and Jack structured their lessons offered insight into the type of support that each teacher provided his/her class. While Maria offered her class a more structured support in terms of the class' organization and plan, Jack made a conscious choice to not provide a concrete plan to his students at the beginning but was still there to direct students to the next task when it was necessary. Although they had slight differences in the organization of their lesson plans, they both shared in the development of a safe classroom atmosphere for students to work together. They were both committed to enabling a learning environment where it was not only safe to make mistakes, but where risk-taking, critical thinking, and respective discourse were encouraged and valued.

What follows are some concrete examples of what I observed. In Jack's classroom, he was constantly circulating around the room and checking-in with groups of students. When he noticed that a student was off-track in his or her understanding, he would talk individually to that

student. However rather than telling him/her the answer, he would ask questions related to his/her work and make suggestions such as “Why don’t you try this…?” At a collective level, after about five minutes into any portion of an activity, Jack would say “I want to interrupt you with one comment… as you think about this… could you also think about…”. In making statements like this, he encouraged students to be critical about their work, reflect on what they were doing and raise the question of whether it made sense.

In Maria’s classroom, she was also constantly walking around and talking to her students. She re-directed and re-focused students as necessary and asked probing questions. Like Jack, she also encouraged her students to think about what they were doing and raised the question of whether their work ‘made sense.’ Unlike Jack, however, she was more structured in her instructions. For example, she would give her students timelines such as “you have two minutes to wrap-up your descriptions before we trade!” This helped students stay on-task and focused within the timeframe of her class.

What are the implications of this more or less structured approaches to teaching mathematics? I would suggest that this difference is grounded in a concern about process and product. In his less structured approach, and in his focus on process, Jack, I suggest, was attempting to enable his students to be more active participants in their learning. In her more structured approach, Maria appeared to want to stay in control of the time students spent on their tasks. She was, it appears, more concerned about the product of what she intended to convey to her students. “You have two minutes to wrap up…before you trade,” is an example, I would suggest, of her sense of urgency in completing tasks. There was a “product” that needed to be “produced,” and it needed to be produced within a specific time frame.

Insofar as Jack focused more on process and less on product, it was not as if Jack was callous with time or, for that matter, with the product of learning. The difference is that he was comfortable with offering his students more time to struggle through their math activity, and less concerned about completing his lesson within the timeframe of his class. In fairness to Jack, he did complete what he intended to achieve. While paying attention to particular individuals who were having more difficulty than others, he would intervene after five-minutes (approximately) and offer hints to the collective, with questions like "…could you also think about…?" His hints enabled his students not only to sometimes shift their focus as they struggled with their math activity, but also to believe that they were in charge of (responsible for) their own learning. What I discovered then is that teaching and learning mathematics that enables student success, is not simply a matter of process versus product. It is not an either-or proposition. Instead it is a both-and way of thinking and acting.

Data Source 2- Linda at Sweet Valley Junior High

The third research participant in my project was Linda - a Grade 9 Mathematics teacher at a Grades 7-9 school in Winnipeg. Linda was allotted twice the amount of time to teach the Grade 9 Mathematics course; she taught eight 40-minute classes per week. When I asked Linda at the beginning of our conversation about how she utilized the extra time afforded to her to teach the Grade 9 Mathematics course, she laughed and said:

> I don't even feel like there is 'extra' time because it's like I'm prepping five different courses within one class, and they're vastly different, because the outcomes that we're focusing on with one modified student could be a Kindergarten outcome, and then another student, I'm doing like Grade 2, 3, 4 outcomes… so I can prep a 10F lesson and it's good to go, but there's variations within that.

Her Story

Linda shared that the students at her school were culturally diverse with a wide and complex range of student needs. The uniqueness of her context was that she needed to pay particular attention to generating multiple and different learning outcomes for students with different learning needs in the same class. Many were newly immigrated students to Canada and spoke English as an additional language. Though her timetable indicated that she was simply teaching two classes of the Grade 9 Mathematics course, she narrated that she had students who were working towards earning one of six different credits within each of those two classes. For example, some students in her classes

(i) Were earning the regular Grade 9 Mathematics credit;

(ii) Were engaged in earning a Grade 9 Transitional Mathematics credit. This group of students were preparing to attempt the regular Grade 9 credit the following year;

(iii) Spoke English as an additional language and were working towards a '10E' credit before they attempted the regular Grade 9 credit the following year;

(iv) Were working on a modified Grade 9 Mathematics program at the recommendation of the school psychologist and learning support team at her school; Within this group of students, there were different plans for each student based on their individual abilities.

(v) Were working on earning a Literacy, Academics and Language (LAL) credit. These students were not only learning English as an additional language, but they have also had large gaps in their schooling due to circumstances like being in a refugee camp for six months.

(vi) Were in a separate Grade 9 Mathematics Advanced class at a different time of day and came to Linda's class to work on the homework they were given in their previous class. While they were working at an accelerated pace on both Grade 9 Mathematics and Grade 10

Introduction to Applied and Pre-calculus Mathematics curricular outcomes and were completing their lessons with another teacher, Linda was still responsible for them during her Grade 9 Mathematics class.

Linda's school prides itself on their inclusive policies and practices. They want all their students to work together, learn from each other, and respect each other in the same class regardless of their language barriers or their differences in abilities. Linda noted that she was particularly committed to "helping encourage an inclusive environment." Whereas I opined that most teachers would feel incredibly overwhelmed and negative about the complexity of her situation, I was amazed at her sense of pride and positivity when she listed all of the different programs occurring in her classroom. For example, she proudly proclaimed that "everyone (in her class) learns about inclusion, everyone lives respect, everyone observes kindness… they learn tolerance." When she spoke about helping students build their confidence in mathematics even if they were working on something different from the rest of the class, Linda passionately expressed:

> In Grade 9, you're going to have kids that don't want to do different stuff than what everyone else is doing, and they're very socially conscious of it… and I work through that every year. I always have at least one student who's like, 'I don't want to do something different'... so my job is to be the chameleon and say, yeah, you're going to work on your Grade 2 stuff, but I'll put the Grade 9 stuff and staple it on top and I'll just say 'you do what you can do,' but everything I'm going to assess is underneath… so I mean it is helping them realize that, being different isn't necessarily bad.

Interview Discovery

What can we surmise from Linda's story? Given the particular context of her classroom, Linda paid particular attention to not drawing undue attention to any one student, and especially to students who were in Grade 9 but still needed to cover "Grade 2 stuff." This was her way of preserving the integrity and confidence of her students. While some of those students may feel ashamed about doing Grade 2 mathematics while in a Grade 9 class, while they may feel embarrassed in being "singled-out," Linda made it her job to enable conditions that did not allow them to be treated differently by others. I would suggest that this is what Linda intended when she "put the Grade 9 stuff and staple it on top" of the "Grade 2 stuff," and made sure that her students understood that "everything" she would assess "is underneath" the "Grade 9 stuff." That was her way of "protecting" the integrity of her students, and it freed her students from feelings of shame or embarrassment and motivated them to do what they were being asked to do.

My Classroom Observation

Through observing Linda teach a single period of each of her two Grade 9 Mathematics classes, I noticed that she demonstrated a great deal of care and compassion for each and every individual in her class. Through speaking with and observing Linda, I was able to learn about and witness some of the teaching methods and strategies that she practiced with the goal of helping *all* her students find success, regardless of their learning outcomes in this course.

In the two classes that I observed, I noticed Linda using a variety of techniques to reach students with very different needs and in ways that preserved the integrity and confidence of her students. This was a consequence of her particular context. For example,

(a) She began the class with mental math, and made sure that every student had questions that were appropriate for their needs and abilities

(b) Rather than lecture on polynomials by only teaching algorithms, she gave each student a set of hands-on manipulatives (algebra tiles) to learn the concept of multiplying polynomials. While all students benefited from using the algebra tile manipulatives, it was especially beneficial for students with English as an additional language to have hands-on visual aids to learn the math concepts.

(c) As students were working on their math problems she circulated and checked-in with as many students as she could to make sure they understood what they were working on. The complexity of student needs added a very different dimension and challenge in that she needed to connect differently with students in the regular program, students in the transitional program, and with students who were in a modified program. When she was among students in the regular program, she helped them gain a deeper understanding of the concepts they were working on by asking probing questions like "can you explain why this is a square rather than a rectangle." However, in relation to students in the transitional and modified programs, she communicated more with the Learning Support teacher that was in her room to see where students were at in their understanding. This further offered her the opportunity to make informed decisions for the next class.

It was fascinating to see the number of things that Linda was able to accomplish over a 50-minute period of time. In my conversations and observations, I became persuaded that the primary intent governing Linda's instructional strategies and actions, regardless of students' being in a regular, transitional, or modified program, was to enable a richer learning experience for *all* her students. This very intention resulted in higher student engagement and it deepened the understanding of relevant mathematical concepts specific to their learning needs.

Data Source 3- Lucia at Bayside High School

Lucia is a high school mathematics teacher at a private school in Winnipeg where students are accepted only if they passed an academic admissions test. Lucia shared that her school administrators organized teachers' timetables to "optimize what is best for student learning." There was, she noted, "a lot of variety… a class never happens at the same time during the day or for the same amount of time…". She went on to provide examples of how their timetable worked. For example, on a Day 1 of the school cycle, students might have a 50-minute mathematics class at 8:30am, but on Day 2 they might have a 90-minute mathematics class at 10:30am. Therefore, on average, teachers were allotted just over two times the amount of time to teach the Grade 9 Mathematics course- approximately 6-7 hours per week.

In addition to offering teachers more time to teach this course, Lucia's private school also has a system where teachers will 'loop' with their students to the following grade. For example, Lucia's current Grade 10 Introduction to Applied and Precalculus Mathematics class is comprised mostly of students that she taught in Grade 9 Mathematics the previous year. She acknowledged that it "adds an interesting, positive aspect in terms of relationship building." Finally, Lucia explained that the administrators at her school organized their mathematics teachers' timetables in such a way that all classes of the same course were running at the same time. For example, all Grade 9 students would be in mathematics class at the exact same time. This offered teachers an opportunity to collaborate and work together if they want to join other classes to do an activity, and it also allows teachers to have common assessments during common times.

Lucia's Story

Lucia brought a unique perspective to her teaching role, as she used to be a high school mathematics consultant for a public-school division in Winnipeg, which included schools that

have a large population of high-risk students. In her role as a math consultant, Lucia has worked in many different teachers' classrooms and had the opportunity to observe many different styles of mathematics teaching. In addition to teaching at her school during the regular school year, Lucia also returned to some of the inner-city schools in her previous role to teach a remedial Grade 9 Mathematics course over the summer. While her current teaching role has more rigid and formalized academic and assessment policies and parameters, she essentially did whatever she professionally deemed best for student learning and assessment in her summer teaching position. However, despite the fact that her two teaching roles are so extreme in terms of the school structure and student population, she described how she still aimed to teach and engage students in the same way.

Interview Discovery

When I asked Lucia about how she utilized the extra time she was given to teach Grade 9 Mathematics, she said that she "thinks of the extra time as an opportunity to 'go deep'". This was not a "luxury" that was afforded to Linda, as we saw in her story. Lucia's context was very different. She said that she spent the first two weeks of the course every year not covering curricular outcomes but providing students with engaging problems in order to "set the stage for group work, autonomy, and thinking". When asked about her organization of a typical class, Lucia provided a more detailed description and said:

> A typical class would be a warm-up of some kind of thinking activity where (students) are solving a problem in groups. Then the new learning will be yet another problem, but really something that would first anchor them in something they've learned before. Then I would introduce a new question that (they) would explore for the majority of the class in groups. Then once I've planned an activity, there's always room for extension to just

> kind of keep going… but I'm always keeping my eye out; listening to the conversations for kind of that bottom group, that last group to reach a certain place before I stop the activity… so it's really driven not by what *I* want to get done but where they are and how fast it takes for them to get there.

It can be surmised that Lucia prioritized her teaching in a methodical and structured way. Her structure can be viewed as follows. Step 1: Preparation. This is the warm up activity. Step 2: Building Blocks. Each new learning and new question are built and anchored in her previous lesson. Step 3: Repeat Step 2. Step 4: Time for students to consolidate their learning through discussions with each other. However, it is not as if this structure of instruction distracted her from personal caring. Lucia also offered her personal level of care in that she was both concerned about her "bottom group," and was mindful of where her "students were at in their learning and how to move them from point A to point B". In speaking with Lucia, it became clear to me that while she prioritized and valued problem-solving, critical thinking, and student mathematical communication in her classroom, she did not ignore the particular needs of each of her students.

Classroom Observation

I felt privileged to observe one of Lucia's classes because of her commitment to develop a student-engaged classroom. Her 70-minute class followed the order of events that she had described in the quote above. She (a) began with an activity in which she provided students with a visual diagram and asked them to problem-solve in groups. Then she (b) spent the majority of the class having students work in dyads on larger problems on vertical non-permanent surfaces (whiteboards). These problems were scaffolded so that they were always anchored in something that they'd learned in the previous school years, which allowed all students to have an entry-

point into learning the new concept. Most of the class time was spent on this stage, and Lucia consistently involved her students in the processes of critically thinking and analyzing the problems they were working on. At times, she brought students together to look at one group's work on the whiteboard and facilitated a group discussion by asking them probing questions about what they were looking at. Then students would go back to their stations and continue working on the next problem she posed. After this, Lucia (c) engaged the class in a short group discussion to make sure the important points of their new learning were clarified, and finally (d) she provided students with time to consolidate what they had learned by writing it down, participating in further discussion with each other, and practicing the concept independently.

Lucia created conditions in her classroom for students to build on their prior knowledge and understanding in order to make further conjectures. Throughout the entirety of her class, she encouraged her students to collaborate with each other in order to gain understanding. Rather than asking the teacher for an answer, she encouraged her students to ask questions and communicate their mathematical ideas to each other. Through speaking with and observing Lucia, I believe that she exemplifies the role of a teacher as a facilitator of learning, rather than the holder of knowledge. She is constantly working towards helping students gain understanding by providing them with engaging problem-solving experiences, asking purposeful and probing questions, and encouraging them to collaborate with each other in order to solve problems.

In speaking with Lucia immediately after my classroom observation, I posed two questions. First, I asked her why she began her Grade 9 class by asking her students to recall a concept that they learned in Grade 4. In response, she reinforced her intention to present students with problems that were anchored in mathematical concepts that they already knew. In doing so, she hoped that all students had an entry-point in ways that were connected to previous learning.

Lucia believed, I suggest, that getting her students to connect with previous learning increases their ability to succeed in Grade 9 mathematics. Secondly, I asked her why she did not give her students a direct and immediate answer when they asked her questions. She responded by saying, "I think about what kinds of hints I can give without robbing them of their thinking". She believed that giving students an immediate answer encouraged them to stop thinking.

In her efforts to enable student success in Grade 9 Mathematics, we notice the power of (a) collaboration, (b) opportunities to think critically in solving mathematical problems, (c) connecting new learning to previous learning, and (d) engaging students in positive discourse as they struggle to arrive at an answer.

Data Source 4- Christina at Rosewood School

Christina is a teacher at a Kindergarten – Grade 12 school in rural Manitoba, and she brings a wealth of experience and knowledge about the Grade 9 Mathematics curriculum to her teaching. She shared that she spent the majority of her career working as a mathematics consultant for her school division and had been involved in the development of the current Manitoba Mathematics curriculum. While Christina's current teaching role is primarily in the high school mathematics classroom, she also works as a learning support teacher in mathematics classrooms for earlier grade levels at her school with students in classes as young as kindergarten. Christina is allotted approximately six to seven hours per week to teach Grade 9 Mathematics. This amounts to double the amount of time to teach the 1.0 credit hour course.

Christina's Story

While Christina acknowledged using more traditional methods of teaching in her classes, she stated that she liked to use math centers approximately once a week "based on Guided Math (Newton, 2019), which is what a lot of the early years teachers are working on right now." She

explained that she learned about Guided Math when she took a course at the University of Manitoba with a former colleague. They had worked on the Kindergarten to Grade 8 Mathematics curriculum together in the past, and her former colleague brought in someone who's area of research was in Guided Mathematics. Christina expressed that "what I liked about (Guided Math) is the way you get to set up the centers."

Interview Discovery

For her 90-minute classes, Christina further explained Guided Math as stations that she sets up around the room with a different task for students to work on at each station. Students spend about 10-20 minutes at each station and rotate through all of the stations by the end of the class. At each station, students are working collaboratively towards a common goal or task. Here is the process through which her students engage in her Guided Math stations.

G- Games: for example, math card sorts, puzzles, or activities on Desmos

U- Using what you know: she provides students with activities such as completing old math contests or problem-solving tasks.

I- Independent Work: she explains that this station is where students work on cumulative exercises to practice what they have been learning

D- Developing New Material: Christina would be at this station helping students learn new content.

E- Expressing Yourself as a Mathematician: This station is where students would participate in activities such completing a mathematics journal question online where they are required to explain and communicate their ideas.

For her shorter classes (shorter than 90-minutes), she explained that she started these classes with a mental math exercise:

> I try to use (mental math) partly as formative assessment and also partly as an introduction to whatever we're doing… it also gives (students) an opportunity to sort of start 'thinking math' instead of whatever they had been thinking before… I find that (students) like it because it 'warms them up' for whatever's going to be coming up… and it helps them get a little bit faster on the skill stuff.

Upon completion of the first part of her class (mental math), Christina clarified that she chose different types of activities for the duration of the class. She combined the traditional method of directly teaching new concepts ("I teach, you listen") and encouraged students to work collaboratively in groups. This offered students an opportunity to practice new concepts or to work on a problem that she had posed to the class.

Throughout my conversation with Christina, she brought up many different technologies that she used and valued as a tool for students to demonstrate their understanding. She provided me with examples of how she used Google classroom technology to get students to share their work, critique and comment on each other's work, and to collaborate with each other about their learning. For example, she "has students keeping an online journal using a Google Doc, which might be a journal question that they have to answer… I'm trying to get at some kind of communication." In a separate conversation, she shared that she encouraged students to contribute to "a class Google Doc that is a math glossary." The purpose of this glossary is that if students were "stuck," as she put it, "they can look and see if someone has defined it, or maybe they might fix the definition."

Christina described how she moved her students to work in groups at whiteboard stations around the room. She encouraged them to "try and answer the question, take a picture of it, and upload the picture to our class Google doc and then move on to the next station." She

acknowledged that this type of activity utilizing technology generated positive discourse in her class. She went on to share:

> The first time (I) did this, some of the kids said, 'well, what if a group's answer is wrong'? And I said 'well then, you should put a comment in there saying 'I'm not sure this is correct and this is why'... it's good for the kids to take pictures and upload them to a Google Doc and have other kids see their work… they get a chance to sort of critique each other's work, and think 'what could make this better so that I'd understand it, and what do I have to put into my own solutions?'

It appears as if Christina was generating an environment inside and outside the classroom where her students were offered the opportunity to communicate and collaborate with each other. At the same time, she offered her students with some "ground rules" on how to communicate respectfully. By suggesting a comment like "I'm not sure this is correct, and this is why," she was in fact encouraging her students to not say something like, "You are wrong," or "You don't know that you are talking about…" At the same time, in asking her students to post their responses in a public forum like a classroom Google Doc, she was also encouraging her students to take a particular risk in their learning. It was a risk to be vulnerable in making mistakes and support each other in learning.

My Classroom Observation

Unfortunately, since Christina taught her 90-minute classes only once a week, I was unable to observe her in her Grade 9 Mathematics classroom. While I did observe Christina in her learning support role in a Grade 2 classroom, the details of those observations are outside the scope of this research.

Data Source 5- Dennis at Monterey School

Dennis teaches Grade 9 Mathematics at a large Grade 7-12 school in Winnipeg. He was allocated approximately twice the amount of time to teach the Grade 9 Mathematics course.

Dennis's Story

Dennis was open about sharing his journey on reforming the way he was teaching his Grade 9 Mathematics classes. He shared how he had only been teaching the Grade 9 Mathematics course for the past three years. Prior to that he taught mathematics at the Grade 7 and 8 grade levels. He agreed to teaching Grade 9 Mathematics because he "figured (he) knew the course content" and "it wouldn't be that different compared" to what he was already teaching in his middle school classroom. In his words, "…my administration moved me up (to teach Grade 9 Mathematics) a couple of years ago when a teacher left. And at first, I was like, 'yeah, I know Grade 9 Math, I can do it'....". Dennis further shared that, when he started his new position, he quickly realized that his classroom makeup was quite different compared to teaching in middle school. Compared to Grade 7 and 8, where "students are in your class and have grown up together to that point," the students in his Grade 9 Mathematics class were:

> From potentially three or four different schools; they don't know each other; they've been taught differently… they have such a mix of ability and behaviors and it's really hard to manage an entire class at once… it's like that for any course, but it was extremely frustrating in math because there are so many kids that are just convinced they can't do math.

Dennis' new reality (context) and corresponding challenges triggered a change in his teaching method. It moved him to question the way he was currently teaching, which was a more

traditional teacher-centered approach, and to ask himself if it was really the best way to reach *all* his students.

Interview Discovery

While in the middle of questioning his teaching methods, Dennis was also completing his Master's program in Mathematics Education. He shared that he had taken a course where he learned about the pedagogy and structure of a Guided Mathematics program (the same one that Christina referred to above). In this university class, Dennis also appreciated the opportunity to participate in a simulation of a Guided Mathematics class. As he expressed:

> I liked how we got up and moved from station to station, and at the end of the station we were like, oh I don't want to stop; I want to keep going… you kind of got the feeling that a student would get.

Sold on the concept of Guided Math, he decided to reform the way he taught his Grade 9 Mathematics class for the 2018-2019 school year. He approached his administration for support and was pleasantly surprised with the support he received. They supported him both with funding to implement his program and with an EA in both of his Grade 9 Mathematics classes. Dennis emphasized how imperative it was to have support from both his administration to proceed with this reformed way of teaching and also to have the consistent support of an EA in his classroom. He stressed that he would not have been able to implement this way of teaching in his class if he did not have this support, especially from the EA that worked with him. He expressed:

> I was afraid to do (Guided Math) before because I thought, 'oh how am I going to manage all of those kids while I'm trying to work with (a small group) of kids over here?' And the big thing is having that EA, right? So, I have one (EA) in one class and I

> have a different one in a different class, but they're both really, really good… I can count on them because at the end of class we usually have a couple minutes where he'll share, 'you know, this student had trouble with this,' so now I know what to focus on (with that student) tomorrow, or 'you know, this one was distracted by that and I think he misunderstood this…' So, I'll pick up with those kids the next day because I am getting that immediate feedback from the EA.

Once Dennis had decided to implement Guided Math in his classroom, and received the support he needed to implement it, he chose to tweak what he learned in ways that were appropriate to his context. For example, in contrast to grouping students with similar abilities, as suggested by a professor in his graduate class, he decided to group them heterogeneously, namely students with differing abilities. When probed further about why he decided to proceed in this manner, Dennis explained that at the start of the academic year, all Grade 9 students completed a diagnostic math assessment. This became his way of identifying what he termed as (a) "red flags" – namely students who failed the assessment, (b) students who "had no problem whatsoever," and (c) students who were "in-between." In intentionally grouping them heterogeneously, he "made sure," as he noted, "that the groups were balanced."

Second, depending on students' understanding of the course content, he was flexible in terms of what they worked on at each station. Usually, he will be at what he called the 'teaching station' (the 'D' of Guided Math) where he was able to work with a small group of 5-6 students to teach them a new concept. The next station (the "I" of Guided Math) is a 'practice' station where students worked together to practice the skills and procedures they learned at the previous station. However, for the 'E' and 'U' stations, he was more flexible in terms of what students worked on. For one of those stations, he had students working on mental math activities, and for

the other he had students working on practice questions from current or past course content. Again, we notice the power of connecting with previous learning. Finally, the fifth station was where students worked together to collaborate on a problem-solving task or puzzle or play a game related to a mathematical concept (the ‘G’ of Guided Math).

When I asked Dennis about how he enjoyed this new way of teaching, he expressed great pride and happiness with how well it is working. In our conversation, Dennis expressed that (a) the structure of Guided Math was much more effective for student learning especially when students worked in small groups, (b) he was in a much better position to see exactly what students understood (or not), and (c) he could make the necessary decisions to better support their learning. In working with a small group of students at the teaching station, Dennis also acknowledged that “they’re not afraid to ask questions in a smaller group” which in turn increased their confidence in mathematics and in communicating with their peers. Dennis noted that he noticed that his students were getting better at collaborating with each other because they were so familiar with working in groups at their stations every day. Finally, he felt that this method of teaching allowed him to complete more formative assessments of his students because he was seeing small snapshots of their learning every day in class. This allowed him to then change or alter his plan for the next class where necessary, because he was able to gain immediate and valuable feedback from his students every day.

My Classroom Observation

Due to timing and logistics, as it was a week before the Christmas break, I unfortunately did not have an opportunity to observe Dennis teaching his Grade 9 Mathematics class.

Summary

In this chapter I introduced the research participants, their contexts, perspectives, teaching strategies and methodologies, and their purposeful intentions. Of particular interest in this chapter was each teacher's story of how they went about the process of enabling student success in Grade 9 Mathematics. As I will further explicate in Chapter 5, the context, intentions, and practices of this purposive sample of teacher research participants are well aligned with efforts to achieve both the NCTM and the Manitoba provincial goals of math education. As reflected in Chapter 2, the collective efforts of these teachers are also affirmations of what we read in the literature. The literature on how to achieve the goals include four particular themes: (a) the occurrence and frequency of mathematical tasks that promote problem-solving and critical-thinking, (b) supporting productive struggle and risk-taking when learning mathematics, (c) facilitating meaningful mathematical discussion, communication, and discourse, and (d) the purposeful integration of technology into the mathematics classroom. In varying degrees, these four themes were displayed by all teacher-research participants. Allow me now to turn my attention to Chapter 5.

Chapter 5 – Thematic Analysis of the Data

In this chapter, I will align the responses and actions of the six teacher research participants with the four broader themes as described in Chapter 2. These four themes ensued from my review of the mathematics teaching and learning processes from both the national and provincial documents, and my review of the literature. What follows is my attempt to interpret and analyze the data collected using the framework of the four themes that were found in the literature. Each theme will be followed by a summary. I will conclude this chapter by identifying five 'Learnings' that emerged as a result of both my interviews and classroom observations of my research participants as they engaged in the process of enabling student success in Grade 9 Mathematics. My use of the language of "learning" simply means the knowledge that I gained through this study.

Theme I- The Occurrence and Frequency of Rich Mathematical Tasks that Promote Problem-Solving and Critical-Thinking

As described in Chapter 2, both the NCTM and the Manitoba mathematics curriculum emphasize the importance of providing students with opportunities to problem-solve and think critically in the high school mathematics classroom. From the perspective of problem-solving, the Manitoba mathematics curriculum (2014) defines problem solving as "engaging in understanding and resolving problem situations where a method or solution is not immediately obvious" (p. 3). They further assert:

> Learning through problem solving should be the focus of mathematics at all grade levels. Students develop a true understanding of mathematical concepts and procedures when they solve problems in meaningful contexts... problem solving is to be employed throughout all of mathematics and should be embedded throughout all topics. (p.10)

Liljedahl (2016) understands critical-thinking from the perspective of one that promotes a "thinking-classroom," namely "one that's not only conducive to thinking but also occasions thinking." This includes "a space inhabited by thinking individuals as well as individuals thinking collectively, learning together, and constructing knowledge and understanding through activity and discussion (Liljedahl, 2016, p. 1).

The NCTM (2014) asserts that teachers must offer students an opportunity to explore and solve problems by posing tasks on a regular basis that require a high level of cognitive demand from the students (p. 24). As noted in Chapter 2, the literature on this subject also supports the notion of frequent and purposeful implementation of tasks that require problem-solving (Stein, Grover, and Henningsen, 1996; Boaler, 2016). It is encouraging to share that all six teacher research participants embraced the idea and the importance of problem-solving in their classroom. However, as I will demonstrate below, while they offered different ways to engage their students in the process of problem-solving and critical thinking, they were also offering more. This is a testimonial to their individual strengths and creativity.

Problem-Solving For What?

Proponents of the Manitoba mathematics curriculum (2014) remind us that "true problems require students to use prior knowledge in new ways and contexts… problems are tasks that are rich and open-ended, so there may be more than one way of arriving at a solution or there may be multiple answers" (p.10). Lucia, Jack, and Maria's views on problem-solving align with this statement with a critical difference. While they believed that good problem-solving questions must be anchored or grounded in something that students already know (prior knowledge), they also affirmed that their students have the potential capacity to go beyond a defined curricular outcome. In other words, they believed that the skills learned in their

mathematics problem-solving processes were also preparatory grounds for problem-solving in everyday life. When Lucia described what she felt was a 'good problem', she explained that, while students in her class usually started with the same problem or at least the same concept, she also intended to teach a life lesson; namely, that differences in problem-solving methods do not necessarily equate to conflict. Lucia mentioned, "...they might be approaching it [problem-solving] differently, whether they're drawing a picture or using algebra, but they're all thinking about the same ideas…". This was an important life-lesson, for Lucia. From a methodological perspective, she, as mentioned earlier, emphasized the importance of making sure to "anchor (the problem-solving question) in something they've learned before". In offering her students with an opportunity to begin with what they know, rather than what they don't know she enabled her students to approach problem-solving with higher levels of confidence and competence. It is as if she understood and embraced Boaler's (2016) formulation that "questions used [to] help develop mathematical mindsets and create the conditions for deep, connected understanding" is crucial to the "difference between happy, inspired students and disengaged, unmotivated students" (p. 57). This method of teaching is also reflected in both Jack and Maria's approach to teaching Grade 9 mathematics.

Jack echoed the idea of giving students opportunities to use their prior knowledge in new ways: "I started giving them the simple (problem-solving tasks) that they could do… like the ones that all students could enter into...". Maria's statements parallel this sentiment when she explained:

> I'm trying to structure my classes and the idea of giving (students) just enough, like talk to them about what they already know… give them just enough so that they're good and then just critique; tacking it on and giving them that next level… that whole idea of

> everybody can enter in, everybody knows this, and then just keep building and building and building and even the kids that are 'lower', even they can enter in!

Lucia's statements echo this idea of 'tacking on' information and asking probing questions to help students increase their levels of confidence and competence and gain a deeper understanding to what she described as 'top-shelf' problems "...problems that are really engaging, really fun, [and] really challenging". She also explained:

> Essentially, I'm starting with the hardest problem now; not 'stepping it out' for them as much… I'm not categorizing it. I get it; giving them the whole (problem) at once, it's overwhelming, but let's anchor it on something we know and then just build on it.

Lucia's methodologies allow all students to enter into the problem-solving process, irrespective of their points of entry. So, students may have higher levels of understanding and hence higher points of entry and others may have a lower point of entry. Focusing on points of entry, however, was not Lucia, Maria, or Jack's primary intent. Jack for example, emphasized that he makes sure there is "always room for extension to just keep going…" He also shared that his lessons are:

> Really driven not by what I want to get done, but where (the students) are and how fast it takes them to get there… there is no real task completion; they can finish something but as soon as they're done, I can give them the next task.

Jack complemented Lucia's approach to problem-solving in his classroom and clarified that he liked to:

> Just give (the students) the hard problem right at the beginning, and then you'll see what they know, and if they already know it then you get to move on the next day… but chances are they can't do it, and all that does is just drive a need to figure it out.

I interpret Jack's approach as also being grounded in his desire to increase the motivation of his students, or as he puts it, to increase their "drive to figure it out." Consequently, the very process of problem solving in a mathematics classroom, serves more than a technical purpose. It is more than getting the "right answer." As we see in this subsection, it also includes appreciating the different ways of problem solving, coaching for higher levels of confidence in mathematics by beginning with what students know rather than don't know, increasing competence in processes of learning, and instilling the "drive" or the motivation to "figure it out," rather than just giving up.

Foundational Experiences for Critical Thinking

Linda and Dennis both discussed the importance of providing *foundational experiences* in their mathematics classes as a means of providing students an opportunity to think critically and grapple with a mathematical problem before they learned any new content. Mason and Erickson (2015) define foundational experiences as:

> Experiences which provide students with opportunities to explore big mathematical ideas rather than focusing on procedural details. The lessons avoid the formal content and symbolic arithmetic associated with those big ideas, featuring instead opportunities for active and interactive engagement with visual and tactile forms of the patterns at the core of the mathematics topic. (p.17)

Linda discussed the importance of providing these larger foundational problems or ideas at the start of a unit as something for students to think about, and so they have something that they can reference as a resource while they learn new concepts. Though Linda admitted she doesn't do these types of activities as much as she would like to, she acknowledged that she "tries to have some activities where I can differentiate [levels of competence] when everyone is

in the same room doing an activity at different levels." Linda offered her conviction in providing students with foundational problem-solving experiences, by saying "I believe they are worthwhile because it provides students an opportunity to always refer back to a starting-point activity."

Dennis shared an activity that he did with his students as a means of providing a foundational experience before he had 'taught' a unit on linear relations. As he said, "...it's cool because when you've done an activity like that, and then you're teaching, you say, remember (reference activity here) and they say, 'oh yeah, right', and they have something to connect it to."

Recall the challenge that I raised in Chapter 1. The challenge for Grade 9 teachers, I noted, is to teach mathematics not only in ways that are aligned with the goals of both the NCTM and the Manitoba mathematics curriculum, but also to teach mathematics within the context of the transitional experiences of Grade 9 students. How can we teach Grade 9 Mathematics in ways that achieve the direct and larger goals of NCTM and the Manitoba mathematics curriculum without alienating or frustrating our students' attempts to understand and use mathematics confidently, accurately, and efficiently? Linda and Dennis appear to offer one response to this question. They would suggest that we begin by first constructing a reference-base (foundation). Students are then offered an opportunity to use that reference base when they are later learning formal mathematics. In other words, they are providing students an opportunity to re-view and rediscover this reference base. The creativity that is expressed in this approach encapsulates critical thinking and includes processes of discovery for life. Mason & Erickson (2015), for example, suggest that providing foundational experiences for students addresses the learning needs of the *whole* student. They recognize:

> Lessons designed with foundational experiences in mind seem to have more room for the students as persons (rather) than content-oriented lessons. The students don't need to 'check their personalities at the door, to be picked up as they leave.' Adolescents are socially oriented. They are curious, creative, and communicative in orientation. In foundational experiences lessons, these qualities are legitimate elements of their engagement. Their experiences are richer than if they were only engaged cognitively with the task. (p.19)

Summary

Earlier in this subsection, I noted that while the research participants in this study offered different ways to engage their students in the process of problem-solving and critical thinking, they were also offering more. In summary, this "more" includes (a) a conviction that skills learned in their mathematics problem-solving processes are preparatory grounds for problem-solving in everyday life; (b) increasing levels of confidence and competence in mathematics (and in life) by beginning with what students know rather than don't know; (c), instilling the "drive" or the motivation to "figure it out," rather than just giving up; and finally (d) focusing on the learning needs of the "whole" student.

Theme II: The Facilitation of Meaningful mathematical discussion, communication, collaboration, and discourse as a way to a) deepen mathematical understanding, b) foster collective learning and accountability, and c) promote equity and social responsibility

In Chapter 2, the importance of mathematical discussions, communication, and collaboration in the classroom was discussed in relation to the literature and research (Mulryan (1994; Sofroniou & Poutos, 2016; Stein, Engle, Smith & Hughes, 2008). The NCTM (2014) reminds us that mathematical discourse in the classroom includes the purposeful exchange of

ideas through classroom discussion, and gives students opportunities to share ideas, clarify understandings, construct convincing arguments regarding why and how things work, develop a language for expressing mathematical ideas, and learn to see things from other perspectives. While all teacher research participants in this study acknowledged the importance of mathematical communication in their classroom and/or demonstrated how they were encouraging it in their classrooms, they differed in their methods of encouragement and what they sought to accomplish.

Setting the stage for group work

Two of the teacher research participants, Lucia and Dennis, discussed how they spent the first one or two weeks of the school year of class time building skills for group work in their classrooms. When discussing her use of mathematical problems that are "engaging, super fun, and super challenging..." Lucia expounded that she promoted different group work skills for about the first two weeks of school just to "set the stage". "I don't give a thought to curriculum; I'm really setting the stage for group work; setting the stage for (students) to be autonomous and for thinking once that stage is set."

Dennis also acknowledged the importance of spending time during the first days of school doing activities where students learn how to learn interactively. At the same time, he acknowledged that this was his opportunity as a teacher to learn the strengths and skills of his students in order to better help him facilitate group work, as the classed progressed. He explained how his school mandates that all students in Grade 9 participate in a camp during the first week of September. He stated that the majority of the activities at the camp encourage team-building and collaboration. Then, during his first week of class with his students, he organized them in

groups where they completed different activities such as math games and group problem-solving activities.

Dennis and Lucia's approaches underscore the idea that both the teacher and students are in a learning mode. While students are learning math through different activities, while they are being prepared for a level of independence and autonomy for thinking, the teacher is learning more about individual students and their levels of math competencies and grouping students heterogeneously. For example, "quieter students" are grouped beside "louder" students. This leads me to the next subsection.

Grouping students heterogeneously

When discussing how they choose which students work together in groups, Dennis discussed the importance of consciously grouping students heterogeneously. As Dennis indicated in our conversation, "I don't want to group my kids homogeneously… I don't pull my similar needs kids aside separately; I keep them grouped with various abilities." Lucia also emphasized the importance of grouping students heterogeneously. She acknowledged that teachers tend to prefer to group students together based on their own opinions and biases. However, she explained why she valued heterogeneous groups:

> Teachers are nervous about grouping students (heterogeneously); they say 'I know this student can't work with that student… they will probably be a disaster'... but how do we help (students) develop that ability (to work together)? We can't just shy away from it all the time… we have to give them the tools to be able to work together.

We notice a particular idea that connects Lucia and Dennis' teaching practices. Recall, for instance, that Lucia did not view different problem-solving methods as contributing to conflict. For her, it was an opportunity to appreciate differences. Again, this idea is surfaced in

her grouping of different students with different abilities. This idea appears to be connected to appreciating differences rather than 'shying away' from differences. Perhaps this is also what Dennis intends insofar as he chose to not organize and group his students "homogenously." It appears as if both teachers were engaged with the practice of giving their students the tools to work together in a heterogenous intellectual and cultural environment. Again, this intent extends beyond giving students the technical skills to solve mathematical problems.

Lack of an 'answer key' as a means of promoting mathematical discussion in groups

Three of the six teacher research participants discussed the same strategy that they use in their classroom with the purpose of encouraging students to collaborate and communicate about their thinking. In the interest of encouraging communication, learning from each other, and increasing autonomy, their strategy was to not provide an 'answer key' to the mathematical problems the students were solving. Jack, for example, believed that:

> The 'no answer' is pretty key because (students) can't just rely on a textbook to tell them if they're right. They have to start developing some autonomy and confidence, and ask themselves 'how do I know that I'm right'… and the discussions that have to happen… they don't have an answer but they're at a table of five people so they can) figure it out and learn how to communicate with each other about what they're ideas are.

Lucia echoed this idea when she explained that not providing an answer key to her students encouraged them to learn from each other in order to solve a problem. She stated that students "get lost, they try different things; but I definitely never tell them (the answer) ... that's what I've been the most deliberate about in the last year and a half; I never tell them the answer." When asked about her students' reaction to this type of learning, Lucia confirmed that

> There is an adjustment for sure. Students think that math is notes and organization and neatness… the role of the teacher is already ingrained. So, when I kind of slipped that on them, it's very uncomfortable for them. (But) they come around; they understand what it is to experience math; what it feels like for them to just be more active in their own learning, to have more autonomy… and just kind of choosing what to learn but valuing their own ideas.

Maria and Jack both acknowledged that their students initially got frustrated with them when they did not provide them with immediate answers as well. As Maria stated,

> The kids who have been traditionally 'good at math' get frustrated with you at the beginning because they want you to tell them how to figure it out, but then (I) help *them* realize that there are five of them in a group and that surely between them they could all figure it out together… as a teacher, you tell them that if they have something written down or to show me, I will talk with them about it, I'll engage with them, but they need to do the first step.

Jack agreed with the pedagogy that grounds the process of not providing students with an answer key, and said:

> I think it's pretty obvious that the thing that is being valued (in our classrooms) is the *thinking process* rather than just the answer… the 'WHY' is this happening, why does this work, how will this be affected if I do this thing to it… there are more opportunities for light bulbs to go off as a result.

Lucia discussed how not providing an answer key to students has in turn caused her to shift the way in which she thinks about and plans her lessons. Rather than spending time working on answer keys and notes to provide to her class, she spends her time thinking about the *types of*

questions she can ask her students when they are collaborating with each other in order to help them to figure out the solutions on their own. As she stated,

> The (students) start to recognize that the only questions I answer are questions that help them keep going right when they're really stuck on something and they need a bit of a hint… that becomes my own planning; thinking about what kinds of hints can I give (the students) without robbing them of their thinking.

Lucia agreed with the benefits that come out of not providing students with an answer key. She discussed how her students initially got frustrated when she didn't give them the answer, but then acknowledged that the student discussion that resulted as a consequence was a more meaningful learning experience *because* of the mistakes that were made. As she stated, "by encouraging students to have these discussions and this discourse, you are empowering students rather than the back of the textbook being what determines if you know your stuff or not."

It is revealing to notice the shared goals of these teachers as they created the conditions for solving problems and critically thinking. Teaching mathematics was also an opportunity for them to enable conditions for communicating, learning by not being afraid of making mistakes, and empowering students with the capacity to think for themselves and in a group. In not providing students with the right answers, these teachers acknowledge that some students may be frustrated with their method of teaching. These teachers, however, believed that this is a method worth trying because it creates the foundations for learning autonomously, learning from each other, and that it is acceptable to make mistakes. At the same time, what I notice as emerging from their method of teaching is a shift in the traditional perception of teachers as knowledge experts, to being experts in both transmitting knowledge and facilitating processes of learning. I define the latter as being expert learning facilitators. While their facilitation methods may have

created some temporary frustration among their students, these teachers were confident that their students will learn more from their facilitated guiding processes.

Learning math in groups as a way of promoting social responsibility and social equity

Three of the six teacher research participants mentioned their experience with students working in groups as promoting social responsibility within their classroom. While I shall return to their experiences in the following chapter, in this subsection I do want to focus on their values as teachers and their intentional efforts to enable conditions of social responsibility and equity in the classroom. When Jack described walking by any classrooms and seeing students "in desks and rows passively listening to the teacher at the front disseminating information," he said,

> I cringe… like I can't take it... I think that this approach kind of goes with the idea that you're learning on your own, and you're just supposed to do it by yourself... and I have no responsibility for you, and you have no responsibility or reason to help me.

Jack valued the principle of 'working together' in groups because it promotes an environment where students demonstrate their willingness to help each other learn. It offers them a reason to care for collective learning. As he elaborated:

> The idea that there is a group responsibility or a class responsibility...that is beyond, you know, *you*. But it also becomes [a] personal responsibility too, because if you don't get something then you're supposed to be talking to somebody about what you're supposed to get… and if you get something, then you also have a responsibility to help that person beside you to figure something out.

Maria agreed that working in groups promotes a group responsibility and that it increases students' self-confidence and willingness to help others. She provided an example of when this

happened in her class and described a student who had started the year off by isolating herself and refusing to interact with other students:

> The student was essentially non-communicative to start with. You know, her just standing near other people was a victory… and then one day she got to explain to somebody else how something else worked, and that couldn't have happened if she was sitting alone at her desk. It couldn't have happened with rows of desks of people silently working on their own… that was pretty awesome.

What is revealing in Maria's example is that creating the necessary environment for group learning can have their intended effects. While Maria took a risk, in that there was no certainty that the student she talked about would actually 'come out of her very shy shell,' Maria believed that the condition of working together offers other students an opportunity to reach out and help. The realization of her intention, was for Maria "pretty awesome."

During my classroom observation of both Jack and Maria, I noticed that part of the activity they had planned involved having students trade their work with each other to mark and critique it, and then give it back to each other for feedback. This encouraged student discourse and dialogue. Rather than asking the teacher for clarification, students went to each other to ask their questions. This method of teaching promoted student autonomy and collective accountability for their work.

When Linda spoke of her intent in having her students of varying abilities work in groups on a particular problem or activity, she acknowledged that one of the major benefits is how social equity and responsibility are promoted amongst her students. As I noted in Chapter 4, in her classroom, she was confronted with many students with differing levels of abilities, including English as an additional language. This context motivated her to construct a learning

environment where “everyone learns about inclusion; everyone lives respect, everyone observes kindness; they learn tolerance.” We notice here, that for Linda, heterogeneity was her opportunity to construct a learning environment for inclusion, respect, and kindness. She went on to provide an example of this, where students in her Grade 9 class were working in groups on a foundational experiential activity that began with counting fish. She described:

> Having (the students) learn a little bit of compassion and having them work in different groups… the students who don’t speak any English are the ones who are going to draw the little fish and they will use the ruler and they are still participating, and they’re learning what it’s like to be in a classroom and have skills and interact in another language and just help other students too… (this helps them) to think in different ways and kind of build up their confidence and realize that math isn’t solitary, and that math can be a group discussion that’s positive. And just for them to have that discussion was really cool because it’s about having kids that still have their ideas and feel that their ideas are valid, and to feel safe in the classroom.

Summary

In summary, what I find encouraging in all of the examples in this subsection, is that teachers in Grade 9 Mathematics are doing more than simply teaching their students the skills or techniques for doing math. Within the context of their classrooms, they are also challenged with everyday life issues like, (a) helping each other learn (collective learning and accountability), (b) generating an environment of inclusivity especially when one is in the midst of differing abilities, (c) building a growth mindset that essentially says that it is “okay” to make mistakes, and (d) showing compassion, respect, and kindness while in the middle of differences. I suggest that these teachers believe that these values are the foundations of social equity and

responsibility. At the same time, what is intriguing to see is the changing role of the teacher as "knowledge expert" to teachers who pride themselves in being "expert knowledge and learning facilitators."

Theme III- Supporting productive struggle and risk-taking when learning mathematics

In Chapter 2, I referred to 'productive struggle' as offering students opportunities to learn more deeply about mathematics concepts and to focus on the relationships between mathematical ideas, as opposed to simply seeking correct solutions. I described how the Manitoba Curriculum document, the NCTM, and other scholars and practitioners within mathematics education also confirm that a focus on productive student struggle is a necessary component of teaching that supports students' learning and understanding of mathematics. As reflected in the literature, this type of teaching which encourages and embraces productive struggle leads to long-term benefits such as students being able to apply their learning to new problem-solving situations (Hiebert & Grouws, 2007; Kapur, 2010; NCTM, 2014).

Four of the teacher research participants described the importance of providing opportunities for their students to engage in productive struggle in their classrooms and the benefits that they see from such an engagement.

Christina, for example, offered her description of what she considered to be her more mathematically-minded students. She described these students as ones who "lean in" to productive struggle and are willing to take risks. She described:

> Good math students as not necessarily just the ones who are really good at memorizing; or because they do the 30 or 40 exercises and they get the pattern and they've memorized the process and they get really high marks… but the other (students) who are *really* good

> math students are the ones who actually *like* math, and they like being presented with a question they've never seen before and try to figure out how to solve it.

Christina distinguished between students who are technically proficient at doing math (memorizing and getting the pattern through practice), and students who are passionate about math (students who *like* math). But herein lies a struggle for teachers. While students can learn math proficiently, how can we as teachers teach "passion" for math? Is that even possible? How can I as a teacher, teach my students to *like* math and hence be courageous in "leaning" into their struggle to understand math? While I raise these questions here, I must acknowledge that any attempt to answer these questions is beyond the scope of this thesis.

Group work encourages productive struggle, risk-taking, and a growth-mindset

Three of the teachers described how they are most successful with encouraging productive struggle and risk-taking in mathematics when they have their students learn collaboratively in groups. Lucia described how she creates opportunities for students to engage in productive struggle by learning from and communicating with one another:

> When you're standing at the front of the room, your goal is to get everyone to understand. It really slows it down. But when you're letting (students) learn from each other, all you really need is a group of kids who 'get it'... and you just let the information fly around… it goes much faster and is more effective. It is uncomfortable for the kids; to be in that space of not knowing; it's uncomfortable- but in an exciting way. And at the same time they get to see that, actually, that's what learning feels like… to be in that place and (asking themselves) 'how do I get out of it?' And they build small steps to get out of that uncomfortable place; they realize that they can do it on their own. That's where that confidence comes from.

Lucia created conditions of discomfort ("to be in that space of not knowing") for the sake of enabling her students to experiencing "what learning feels like." Going through the process of struggling from not knowing to knowing was her way of facilitating confidence-building. This made her struggling-learning process 'productive.' However, it was not as if she left her students to struggle on their own. She was there as their teacher to guide them through the process of not knowing to knowing. It is in this way that she embraced her new role of teacher as a facilitator of learning.

Maria described this confidence-building process a little differently. In having her students learn collaboratively in groups, she explained that it encouraged them "to take risks and work through problems" because they were doing it with their peers:

> The kids learn better, and it is a lot more meaningful… there's just some really, really good experiences for some kids, especially the 'lower' ones who have never felt confident in math; and this year they're actually standing up and saying 'oh I get this part, but not this part'... and they're more willing to take risks and work with their group to understand something because they don't feel like they're alone.

Peer support and collaboration appear to be critical pieces of this confidence-building process. It was an environment where students were able to learn from each other. Through collaboration, they felt that they were not alone in their struggle to understand math. At the same time, peer support appears to have a positive effect on students' willingness to invest in trusting others. Through such an investing, students felt "more willing to take risks." Insofar as trust is a central issue in any human relationship, it appears, again, that these teachers are teaching more than mathematics.

Dennis echoed this idea that students were more willing to take risks and make mistakes when they were learning because they trusted each other. He also described how creating an environment where risk-taking and making mistakes is encouraged results in students having more of a learning-growth mindset:

> When (there is) someone across the table saying, 'I don't understand', others are thinking, 'oh good, I'm glad you said that because I don't understand either!' And then the next time, they're not afraid to say 'I don't understand' because they saw someone else do it, you know? It's a little bit contagious that way. I'm trying to encourage them (that) it's good to make mistakes. You know, the whole thing about the growth mindset and making mistakes helps your brain grow and develop.

Dennis referenced how important it is to encourage a growth-mindset in his classroom and he was particularly mindful of reminding parents to do the same.

> I'm still working on the parents… I had one student show up with his parents and his Dad said something like, 'well I'm not surprised, I never did very well at math'... and I said to the kid, 'what do you tell your Dad?' and the kid said 'Dad it's not genetic'... it's good because students and parents need to hear those messages.

Dennis appears to be suggesting that students are not simply 'born' with the capacity to "do math." It is a skill that can be learned and nurtured. To that end, he continued to promote learning in the classroom, and to recommend that parents nurture that 'growth-mindset' at home.

Lucia also described her vision of a successful student as one who is willing to engage in productive struggle and take risks. For her, this in turn increases their self-confidence in their ability to learn and promotes a growth mindset. She explained that:

> My idea of success is not what students learned, but if they can see themselves differently… at the final exam for example... when I was talking to this girl, she was doing a problem with fractions and she got to the very end and it was wrong, and she sat there... just like 'okay why is this wrong, let me try again…' and that moment right there; the idea that you can get stuck and actually think that you can get yourself unstuck or try again is already a shift that will help you in life.

What is enlightening and educational in Lucia's vision of success is that for her, it was not simply a matter of getting the right answer. Instead, it was more important for students to move productively from feeling stuck to being unstuck. And she experienced this shift while she witnessed one of her student's struggling with her response to a math problem "during the final exam- she did not give up. She did not let her frustration get the better of her. She gave herself the 'gift' of trying again." It is this growth or 'shift,' as Lucia puts it, that will "help you in life." We could say that teaching math was important because it was her opportunity to prepare her students to live productively.

Summary

Before proceeding to the next theme, allow me to capture the learning gained in this subsection. These teachers supported productive struggle and created conditions for students to take risks when learning math for a higher purpose. In other words, they were not simply interested in allowing students to get the right answer. While this may be the view of 'outsiders looking in,' perhaps what is not truly appreciated is how these teachers are themselves guided by a higher purpose. This higher purpose can be seen as (a) creating conditions where students can feel their discomfort; (b) encouraging students with the strength to move from feeling stuck (feeling uncomfortable) to becoming unstuck (being comfortable); (c) gently nudging parents to

develop a nurturing "growth-mindset" with their children; (d) indirectly teaching that "being proficient in math" is not a genetic condition; (e) giving students an opportunity to invest their trust in others; and (f) being a guide, and not simply a knowledge expert, in facilitating learning and confidence building. I will be the first to admit that I am truly inspired by their deeply committed principles for teaching, learning, and being engaged in the process of what it means to struggle productively.

Theme IV- Purposeful and effective integration of technology into the math classroom

The authors of the NCTM (2014) note that "an excellent mathematics program integrates the use of mathematical tools and technology as essential resources to help students learn and make sense of mathematical ideas, reason mathematically, and communicate their mathematical thinking" (p. 5). The Manitoba mathematics curriculum (2014) also highlights the importance of using technology effectively to contribute to and support the learning of a wide range of mathematical learning outcomes. In Chapter 2, I reviewed Desmos technology as one tool that is aligned with the goals of technology in mathematics education as described by the Manitoba mathematics curriculum (2014).

> Technology has the potential to enhance the teaching and learning of mathematics. It can be used to explore and demonstrate mathematical relationships and patterns, organize and display data, generate and test inductive conjectures, extrapolate and interpolate… (and) increase the focus on conceptual understanding by decreasing the time spent on repetitive procedures. (p. 11)

In my classroom observations of both Jack and Maria, I noticed that they used Desmos graphing technology and motion detectors as a meaningful way to provide students with context for graphing scenarios. For example, students in their classes were asked to create graphs using a

motion detector that recorded their movements. This type of activity provided students with a real-life context to better understand how to interpret linear and nonlinear graphs. Students were then provided with graphs created from Desmos technology and were asked to try and re-create the motions and graphs as best as they could. After they had been provided with these experiences with technology, students were then asked to draw graphs based on given scenarios and alternatively to write a scenario based on a given graph, without the use of technology. As described in Chapter 2, this type of activity allowed for the opportunity for students to have immediate feedback. King (2017) noted that the instant feedback provided through Desmos enables students to engage differently and it makes the experience more enjoyable overall, because students are able to explore what happens to the graph of functions as the parameters vary, in real-time. I was able to witness both Jack and Maria integrate Desmos technology into their teaching in a way that was significant and meaningful for students' understanding.

As described in Chapter 2, another theme that was found in the literature was the idea of students taking more accountability for their learning via the use of technology. While they were speaking directly to the idea of learning in a flipped classroom, Bergmann and Sams (2012) noted something significant that is applicable here:

> Some students are being asked for the first time to take ownership of their education. Learning is no longer an imposition on their freedom but rather a challenge to be unpacked and explored. As the teacher gives up control of the learning process, the students take the reins, and the educational process becomes their own. (p. 60)

Christina's use of technology in her classroom contributed to this idea of student accountability and ownership of their learning. Her use of an online classroom community within her Grade 9 Mathematics class through the use of Google Documents encouraged an environment where it

was not only legitimate to showcase your work and be proud of it, but it was also permissible to make mistakes and learn from each other. For example, her use of Google Documents for students to share their work and then comment and critique each other's work not only encouraged student accountability and ownership for their own learning, but also the opportunity to engage in positive discourse about each other's work. As Christina stated, "...it gave them a chance to see what other (students) were thinking… our students are fairly comfortable doing this and taking those risks." What must be noted here, is that taking risks in an online environment is completed and connected to activities in the classroom that promoted trust. This issue with trust was addressed under Theme III above.

In completing my research on different educational and instructional technologies, I questioned the idea of vertical non-permanent surfaces (such as whiteboards or glass walls) as an educational 'technology'. Both Jack and Maria spoke about their use of vertical non-permanent surfaces (such as whiteboards) as a tool that they used to have students work in groups on mathematical problems. Jack reinforced why he valued having students working in groups on whiteboards, as he appreciated having students "at the boards and talking math instead of it being isolated ... at a table with a piece of blank paper in front of them." Maria emphasized the importance of using whiteboards in her classroom as a tool to work collaboratively and acknowledged:

> You see the whole point of this group work is that (students) were all talking and working together, and they're arguing about their points and they're 'cheating' off each other around the room… and you take kids around (the room) and you say, 'here's what (these students) did; look at how they answered this question- what a cool interesting way to solve the problem.

Jack also stated that, when he began to think about reforming his teaching of mathematics, he was "trying to improve problem-solving abilities through group work… ironically, without whiteboards; but in the end, whiteboards was all I needed… table groups just wasn't enough." Christina also expressed her interest in having her students work in groups on vertical non-permanent surfaces in class. She explained that, when solving problems on vertical surfaces, her rule is that every group only gets one marker to write with, and that every person in the group must take turns writing with every question. While this may seem simplistic, she explained that this reinforced in her students the need to engage in a discussion about how to solve a problem and what should be written down. As she stated, "kids really liked working in a group like this because it gave them a chance to find out how to do something or find out how to do something in a different way."

Through my classroom observation of Lucia, I witnessed her use of vertical non-permanent surfaces in her classroom. She had students learning in groups at stations around the room on different questions. As they worked, she circulated the classroom and would interrupt their discussions to ask questions such as 'how did you get that?' and 'can you explain this part to me? Why did you make the graph go up here?'. At times she would go to another station and say, 'can someone explain what is happening in this graph to someone who is not in this group'. At other times she would invite the entire class to look at one group's work on the whiteboard and lead a brief discussion on what they were witnessing, before sending them back to their stations to continue collaborating together.

Summary

In this subsection, we notice that the teacher research participants chose to integrate technology into their teaching not simply for the sake of saying that they are 'using technology'.

Rather, it seems that their choices to integrate technology into their teaching serves to achieve more complex goals. These goals include (a) using technology as a means to provide a meaningful experience that is grounded in a real-life context so that students can relate to it, (b) choosing technologies that provide immediate feedback to students, so that they are able to make predictions and explore in real-time and therefore increase their engagement with the content, (c) using different technological tools as a means of encouraging student responsibility for themselves and accountability amongst their peers, and (d) using certain technologies as a tool to encourage student communication, discourse, and collaboration.

Moving Forward

Allow me to recall the purpose of my research. In Chapter 1, I noted that the purpose of this research project is two-fold. First, I aimed to study the different methods used by a purposeful sample of Grade 9 Mathematics teachers who are particularly focused in enabling success for all students. Second, I also aimed to ascertain in what ways their teaching methods and processes align with their own goals and the goals of mathematics education that are described by the National Council of Teachers of Mathematics (NCTM) and the Manitoba mathematics curriculum. I particularly stated that my hope is that by learning from teachers who may be teaching this Grade 9 course in substantially different ways, I might better inform myself and other teachers on how they might teach Grade 9 Mathematics to help all students find success. So, what can I surmise from my interviews and classroom observations and analysis of information provided?

The knowledge that I gained through my interviews and classroom observations is that these teacher research participants are doing much more than simply changing their technical modes of teaching in order to better enable student success. What follows is a description of the

learning that emerged from my interviews and classroom observations. I have thematically organized this description into what I call five 'Learnings'.

Learning #1: Enabling Student Success: From Teacher-Centered Instruction to Building Community

I discovered that all of the teacher research participants are moving away from a more traditional teacher-centered approach to instruction ('I speak, you listen') as their primary method of teaching mathematics and towards what Lucia described as the "building of community." While some teachers may be further along this continuum than others, they all seem to acknowledge, either directly or indirectly, their attempts to move away from lecturing as being the only method of teaching. Lucia, as I noted, may have synthesized their collective intent to facilitate learning best, with her comment that what she really intended to achieve was "building more of a community." As reflected in the preceding pages, building community can be seen through these teachers' efforts to do things such as (a) spending time at the beginning of the school year dedicated solely to encouraging positive habits when working in groups, (b) creating classroom activities that encourage collaboration and communication amongst their students, (c) providing opportunities for students to engage in positive discourse and productive struggle about their learning by means of not providing an answer key, and (d) grouping students together in heterogeneous ability groups so that all students can learn from each other.

Learning #2: Enabling Student Success: From Knowledge Experts to Experts as Learning Facilitators

The second idea that emerged from the data is the apparent shift in what the teachers perceive their role to be in the classroom, and the movement of their role from being a knowledge expert to one who is both a knowledge expert and a facilitator of learning. As Maria

expressed, “I was somebody who was extremely traditional: rows, the whole nine yards; I lectured, did the set of questions, provided examples, you know, the routine- and I was very successful in that I viewed myself as a good teacher”. Through my classroom observation of Maria, it was clear that she has made a large shift away from her previous idea of what a ‘good teacher’ was and has moved toward the role of a facilitator of learning, where she provided students opportunities to explore and learn together and questioned them and helped guide their thinking alongside them as they worked.

As learning facilitators, these teachers acknowledged that they themselves struggled with being perceived as one who did not have the answers or risking the judgment (by some students) that collaborative learning is simply a waste of time. Unlike traditional lecturing methods of teaching, facilitators of learning appear to be committed to the value of, as Maria noted, “giving students a voice.” It is not as if students do not have a voice; instead they are offered the opportunity to ‘voice their voice.’ As reflected in the preceding pages, this shift from being the knowledge expert at the front of the room to a facilitator of learning alongside the students can be seen through teachers’ efforts to (a) create classroom conditions in which students are learning from each other and the teacher is posing purposeful questions alongside them, (b) not providing an answer key to the students but rather encouraging them to learn from each other and question and critique their own work, while the teacher clarifies understandings and pushes their thinking further by asking probing questions, (c) providing opportunities for students to showcase their work to each other, so that they themselves become the experts of the course content, and thus take more ownership for each other’s learning.

Learning #3: Enabling Student Success by Building Competence and Confidence Cumulatively

When reforming the way that they taught, these teachers were always cognizant of the fact that mathematics is cumulative, and that Grade 9 Mathematics is just one part of a large continuum of skills**.** More specifically, the third idea that emerged from this data is that all of these teachers approached learning mathematics from the perspective of building on what students *already know*, rather than focusing on what they don't know. Jack discussed how he has been asking himself "how do we dismantle units, and how do we bridge the connectivity between all of our math content as much as possible…" and when he discussed how he and Maria had worked together to create cumulative exercises for their Grade 9 students, he expressed that "they are cumulative; they are not just focused specifically on our course content... I think that there is a good attempt to make sure that learning from Grade 7 and Grade 8 is still relevant and being reviewed." As reflected in the preceding pages, this shift in focus to building on what students already know in order to enable student success can be seen when these teachers do things such as (a) provide students with big-picture foundational experiences so that students can learn new concepts by drawing on their contextual experiences, (b) organize their lessons in ways that provide 'grounding' or 'anchoring' activities at the beginning so that all students have an entry-point into the new learning, and (c) provide students with opportunities to solve problems that are based in mathematics learning from previous years and then 'tack on' new information for them on a need-to-know basis. By organizing their teaching in this way, these teachers are helping students realize that their new learning is actually grounded in things they already know, which thus helps build student confidence and competence in learning mathematics.

Learning #4: Enabling Student Success: It Takes a Village

In speaking with all of the research participants, the fourth idea that was evident in this data was that teachers could not be engaging in the reform of their mathematics classrooms without the support of their administration and their colleagues. For example, in our follow-up conversations after I observed their classrooms, Jack and Maria discussed how they have a principal who is very supportive of what they are trying to do in their classrooms. They explained that they were each given five days of release time to work together on their programming specifically for Grade 9 Mathematics. In addition, their principal also provided other days of release time for their entire mathematics department in Grades 7-12 to work together to collaborate and plan.

In my conversations with Linda, she acknowledged the importance of the team approach with her colleagues in order to program for students. She referenced how important it is that one of the resource teachers at her school has done the programming and provided support for Grade 9 students in mathematics who are struggling, which makes her job much more manageable. As she expressed, "I would be in a lot worse off state mentally about work than I would be otherwise without the teamwork in our math department… there is a lot of communication and it's awesome." Dennis also discussed the importance of having support in his classroom when he explained that "the big thing is having that EA (Educational Assistant) because the EA feedback, offered him another opportunity to understand where his students were at in terms of their learning and what he needed to do for his next class. In all of these examples, it is worthy to note that the support and collaboration of administration and colleagues is paramount for teachers to be able to engage in reform of mathematics teaching with the goal of better enabling student success.

As reflected in the preceding pages, it is evident that teaching reform is only truly possible with (a) the support and encouragement of a teacher's administration through i) constant dialogue and discussion ii) financial support in order to implement programs, and iii) release time to plan and co-plan with others, and (b) the support of and collaboration with teaching colleagues, learning support teachers, and educational assistants in order to collaborate about how to best help the range of diverse students in their class.

Learning #5: Enabling Student Success through Accountability and Co-Ownership of Learning

In reforming their mathematics teaching, these teachers are also trying to promote student autonomy and ownership over their learning, as well as promoting a sense of responsibility for the learning of their peers. As Jack and Maria described their reformed teaching methodologies, they continued to acknowledge how using methods such as solving problems in groups on vertical surfaces encouraged a sense of ownership and co-ownership among their students. As Jack explained, "there's always been this 'math thing' that you're supposed to get through this curriculum, or math is being 'done to me' and it just seems like there's this sense of ownership (among the students) because we're not having to force them to learn in the same way anymore; it's a socially engaging activity."

In my conversations with Linda, she described another teaching method that she used to promote student ownership and responsibility. She explained that she was trying to spend more time working on the affective domain of learning, and she did this by "talking to the kids and setting goals together. We go through the outcomes and I ask them 'how did you study? What did you do to prepare? What can we do differently?" She acknowledged that she has received some pushback from teachers who say, "this is taking time out of my teaching" and "(setting

goals) is not part of teaching my curriculum." However, she asserted that the "definition of insanity is doing the same thing over and over again and expecting different results. So that's why I talk to the kids and we set goals." Linda's prioritization of helping students set goals for themselves is aligned with the Manitoba mathematics curriculum (2014) which suggests "to experience success, students must be taught to set achievable goals and assess themselves as they work toward these goals" (p.4). As Lucia summarized, "when you empower kids to be autonomous, they just start taking it into their own hands. They start making decisions that are best for their learning."

I will now turn my attention to Chapter 6: Data Interpretation and Recommendations. In Chapter 6, I will interpret the experiences and stories of my research participants through the lens of my five Learnings. Each "learning" will be followed by a specific of set of recommendations in relation to enabling student success in Grade 9 Mathematics. To give credit where credit is due, I must admit that these recommendations emerge from my research participants and flow from my interpretation of what they offered.

Chapter 6: Data Interpretation and Recommendations

Introduction

Allow me to recall the purpose of my research. In Chapter 1, I noted that the purpose of this research project is two-fold. First, I aimed to study the different methods used by a purposeful sample of Grade 9 Mathematics teachers who are particularly focused in enabling success for all students. Second, I also aimed to ascertain the ways in which their teaching methods and processes align with their own goals and the goals of mathematics education that are described by the National Council of Teachers of Mathematics (NCTM) and the Manitoba Mathematics curriculum. I particularly stated that my hope is that by learning from teachers who may be teaching this Grade 9 course in substantially different ways, I might better inform myself and other teachers on how we might teach Grade 9 Mathematics to help *all* students find success.

As a way of proceeding, allow me to share both the context and the essence of what I discovered in my research. When I began this research project, my expectation was that I would end up finding one universal answer to the question of how to best enable success for all students in Grade 9 Mathematics in Manitoba. I expected to offer my teaching community a 'golden key' to unlock the challenges confronting them and offer them with a one-size fits all check-list (universal) of answers. However, in completing this research, I realize that while all six teacher research participants were working towards reform and change in the ways in which they taught Grade 9 Mathematics, their choices of *how* to reform their teaching was grounded in their teaching context. Each teacher in this research project was faced with their own unique context, which contributed to their decisions and approaches when teaching this course. As outlined in Chapter 5, I discovered that their respective contexts, combined with their personal values and pedagogies, influenced their decisions and what they chose to prioritize. What I discovered and

learned then, is the significance of context. By definition, context is particular, not universal. Every context raises particular questions and they demand particular answers.

In Chapter 3, I also noted that my qualitative research project aimed at a phenomenological model of data analysis and interpretation. Within the context of this research, the phenomenon under investigation is how my purposive sample of teacher research participants experience their role in enabling student success in Grade 9 Mathematics. In particular, the rationale behind this approach is to understand why this group of teachers do what they do by entering into their field of perception – to see why they do what they do as they see it.

What I discovered is that the essences of their experiences of their efforts to enable student success in Grade 9 Mathematics is grounded in their purposeful intentions. While they were all engaged in the task of teaching Grade 9 Mathematics, they intended more than to simply teach mathematics. As I will demonstrate in this chapter, their purposeful intention was critically aligned with a goal of the NCTM (2014): "Productive Disposition." Practically, this particular goal involved creating classroom conditions where students are empowered to (a) appreciate and value mathematics, (b) value and commit themselves to life-long learning, and (c) become mathematically literate citizens.

In this Chapter, I will return to the experiences of my teacher research participants to obtain a comprehensive description that "provides the basis for a reflective structural analysis that portrays the essences of [their] experiences" (Moustakas, 1994, p. 13). I will proceed by collecting and interpreting the essence of their experiences through the five critical learnings that I described in Chapter 5. These five critical learnings will form the structure for a reflective analysis of the experiences of my teacher research participants. Through my reflection of their experiences I will also offer eight recommendations for enabling student success in Grade 9

Mathematics. In offering these recommendations, I want to be clear. The audience for these recommendations are a combination of *partners* in the educational process. These include the Education and Training department for the Manitoba provincial government, the faculties of education at universities in Manitoba, school superintendents, school administrators including principals, teachers, community leaders, and parents. As I will note later, this is the "village" that will need to be actively engaged in enabling student success, not only in mathematics but in life.

Learning #1: Enabling Student Success: From Teacher-Centered Instruction to the Building of Community

The first learning that emerged from this research is that all of the teacher research participants were intentionally moving away from the more traditional teacher-centered instruction method of teaching mathematics towards what Lucia described as the "building of a learning community." As reflected in the preceding pages, building community can be seen through these teachers' efforts to do things such as (a) spending time at the beginning of the school year dedicated solely to encouraging positive behaviors when working in groups, (b) creating classroom activities that encourage collaboration and communication amongst their students, (c) providing opportunities for students to engage in positive discourse and productive struggle about their learning by means of not providing an answer key, and (d) grouping students together in heterogeneous ability groups so that all students can learn from each other. Each of these four practices, which I would also offer as recommendations, and their underlying intents deserve a little more attention.

(a) Positive behaviors

When teachers in this research project discussed how they devoted time at the beginning of the school year dedicated solely to encouraging positive behaviors when learning in groups,

their underlying *intent* was to create a safe and comfortable environment with their students, so that all students felt comfortable sharing their ideas and thoughts without fear. These teachers believe that spending this time purposefully at the beginning of the year, doing low-stakes activities such as playing games in groups, encourages students to later take learning risks. This idea is supported by Boaler (2014) who asserted that "failure and struggle do not mean that they cannot do math- these are the most important parts of math and learning" (p.172).

Recommendation #1:

That teachers be prepared and supported (by both the Faculties of Education and in the respective Schools) in their efforts to create a classroom environment that is safe for students to take risks and make mistakes because these important parts of math and learning can become a way of building community.

(b) Collaboration and communication

Teachers also fostered and built a community in their classroom by encouraging collaboration and communication amongst their students. It seems that the underlying *value* in getting students to communicate and collaborate in order to understand the mathematics content is that teachers are trying to promote social responsibility within their classroom. When Jack described walking by a classroom and seeing students in desks and rows passively listening to the teacher at the front disseminating information, he said:

> I cringe… like I can't take it. And if I see a bunch of students just sitting silently in a room and there's an overhead on, I cringe… I can't take that. I think that this approach kind of goes with the idea that you're learning on your own, and you're just supposed to do it by yourself, and 'oh you're better than me and I have no responsibility for you, and you have no responsibility or reason to help me.

Jack asserted that having his students work in groups promotes social responsibility to learning, rather than an individualistic task. As he stated:

> The idea that there is a group responsibility or a class responsibility, and that it's beyond, you know, *you*. But it also becomes [a] personal responsibility too, because if you don't get something then you're supposed to be talking to somebody about what you're supposed to get… and if you get something, then you also have a responsibility to that person beside you to figure something out.

While Maria agreed with the notion that working in groups promotes social responsibility, she noted that it also offers students with an opportunity to contribute to the learning of their peers, which in turn increases [she hoped] their self-confidence and willingness to help others. She provided an example of when this happened in her class and described a student who had started the year off by isolating herself and refusing to interact with other students:

> The student was, you know, essentially non-communicative to start with. You know, her just standing near other people was a victory… and then one day she got to explain to somebody else how something else worked, and that couldn't have happened if she was sitting alone at her desk. It couldn't have happened with rows of desks of people silently working on their own… that was pretty awesome.

Recommendation #2:

That teachers organize their classroom activities in ways that promote social responsibility amongst their students. As noted in Chapter 2, this concept is exemplified by Mulryan (1994) when she discussed the responses of students when they were asked about the purpose of cooperative small- group work. In their responses, students referred to the learning of

social skills not specifically related to the actual learning task when they worked in cooperative groups. For example, students acknowledged that when working in groups, they learned from each other, helped each other, learned to work with others, got to know each other, and learned to get along with other people (p.283).

(c) Positive discourse

When teachers provided students with opportunities to engage in positive discourse and productive struggle about their learning by not immediately giving them a direct answer, one of the outcomes is that it promotes a classroom environment where students are responsible, autonomous, and empowered to take charge of their own learning. Jack stated his experience in providing these opportunities in his classroom when he explained that "by encouraging students to have these discussions and this discourse you are empowering students". As Maria described, one of the outcomes of encouraging her students to participate in productive struggle and discourse is captured in this sentence, "I think the biggest thing is you give the kids a voice." I would suggest that it is not as if students do not have a voice. It is not as if teachers need to "give" them a voice. Rather, I interpret our role as teachers as one where we need to create conditions for the emergence of student voices. This, I would suggest, is what Maria means by kids developing a voice. In enabling her students to "voice their voice," she is offering her students an opportunity to be more active, to contribute to their own learning, and to feel that they are a legitimate part of their own and their peer's learning. To paraphrase Brion-Meisels, a faculty member at the Harvard Graduate School of Education, when schools find ways to welcome student opinions, and partner with students "as stakeholders in their own learning," they equip students with tools for lifelong success (as cited in Shafer, 2016, Para 2). At the same time, as Mitra (2003) affirmed, through "increasing 'student voice' in schools students have the

potential for contributing their opinions on a variety of levels, including sharing their views on problems and potential solutions in their schools" (p. 289).

Recommendation #3:

That teachers continue their innovative efforts to create empowering learning conditions that allow for the emergence of student voices.

(d) Learning in heterogenous groups

When teachers choose to group students together in heterogeneous ability groups, so that all students can learn from each other, they are cognizant of the diversity of students and the opportunity that it can provide for the building of a healthy community. Some teachers in this research project had a wider range of diverse students than other teachers. Some contexts included students who are recent immigrants to Canada; students with differing English language speaking skills; students with different level of mathematics acumen; students with cognitive delays; and students who have been identified as gifted students. However, regardless of the range of students, all of the teachers acknowledged the importance of grouping their students heterogeneously so that all students have an opportunity to work with and learn from every other student at some point during the course. Lucia summarized it best when she discussed the importance of grouping students in heterogeneous ability groups when she stated:

> The biggest surprise teachers always see is that kids that they've identified as their strongest; they have a lot of trouble with getting them to think. And that's an eye opener because we must question what do we value? We must give students a chance to show their strengths differently.

When Linda spoke of her experiences with having her students of varying abilities work in groups on a particular problem or activity, she acknowledged that one of the major benefits is

how social equity and responsibility is promoted amongst her students. She affirmed that in her classroom, the fact that there are so many students of differing levels of abilities offers "everyone" an opportunity to "learn- about inclusion; everyone lives respect, everyone observes kindness; they learn tolerance". Herein lies another example of the experience of her purposive intent. She went on to provide an example of this learning, where students in her Grade 9 class were working in groups on a foundational experiential activity that began with counting fish. She described:

> Having (the students) learn a little bit of compassion and having them work in different groups… having a student who doesn't speak any English; they're the ones who are going to draw the little fish and they will use the ruler and they are still participating, and they're learning what it's like to be in a classroom and have skills and interact in another language and just help other students too… (this helps them) to think in different ways and kind of build up their confidence and realize that math isn't solitary, and that math can be a group discussion that's *positive*. And just for them to have that discussion is really cool because it's about having kids that still have their ideas and feel that their ideas are valid, and to feel safe in the classroom.

Recommendation #4:

That teachers continue to create learning conditions where students feel included, respected, and confident. Creating a values-based teacher-leadership professional development program could be one way of instilling and promoting the need for generating respectful and inclusive classroom experiences. This concept is strongly supported in the Manitoba provincial document *Supporting Inclusive Schools: A Handbook for Resource Teachers in Manitoba Schools (2014)* which states "In a safe and inclusive learning environment, the concept of

diversity encompasses acceptance of and respect for each other. All students are valued members of the learning community. This means understanding that each individual is unique, and recognizing individual differences" (p.3).

Learning #2: Enabling Student Success: From Knowledge Experts to Experts as Learning Facilitators

The second learning that emerged from the data is the shift in what teachers perceive to be their role in the classroom, and the movement of their role from being a knowledge expert to one who is a facilitator of learning. As Maria expressed, "I was somebody who was extremely traditional: rows, the whole nine yards; I lectured, did the set of questions, provided examples, you know, the routine- and I was very successful in that I (viewed myself as a) good teacher". Through my classroom observation of Maria, it was clear that she has made a decisive shift away from her previous image of a 'good teacher' and moved towards the role of being a facilitator of learning. As a facilitator of learning, she provided her students with opportunities to explore and learn together, and she raised questions and helped guide their thinking alongside them as they worked towards "finding the right answer." As a facilitator of learning, Maria was motivated by both the process and the product of learning.

As learning facilitators, these teachers acknowledged that they themselves struggled with being perceived as one who did not have the answers or risked the judgment (by some students) that collaborative learning is simply a waste of time. However, for them, this was a risk worth taking. While they created conditions for productive struggle with their students, they themselves embraced their own struggle with their role as experts as a productive struggle. In their case, however, it was a struggle that was grounded in their purposive intent to empower student learning.

As reflected in Chapter 5, this shift from being the knowledge expert at the front of the room, to a facilitator of learning alongside the students, can be seen through teachers' efforts to (a) create classroom conditions in which students are learning from each other and the teacher is posing purposeful questions alongside them, (b) providing opportunities for students to showcase their work to each other, so that they themselves become the experts of the course content, and thus take more ownership for each other's learning. Jack described how his role has changed as a teacher and said:

> I think back to you know, crummy lecturing kind of days where I'm giving examples at the front of the room, and now I'm able to engage with individual students who need help as opposed to spending the majority of my time on my lecture and just hoping that the kids get it.

While observing Jack in the classroom, I noticed that he was constantly circulating around the room and checking-in with groups; he went up to students and spoke individually with each student. If they were not doing something correctly on the whiteboards, he would not just tell them the answer, but rather he would ask questions like 'have you tried this? What made you do that? Could you show that in a different way?'.

Lucia summarized her role as a facilitator of learning succinctly when she said:

> I'm trying to show students that teachers can sit beside them and question and learn… teachers need to understand the math at a higher level than the students, but they don't need to always have the answer. When you're standing at the front of the room, your goal is to get everyone to understand; it really slows the learning down. But when you're letting them learn *from each other*, all you really need is a group of kids who get it, and you often have them, and you just let the information fly around.

In summary, I would suggest that all teachers made an intentional decision to transition from being a "sage on the stage knowledge expert" to being a "guide on the side of students," (learning facilitators). While these may appear as 'hackneyed slogans,' is this really an objection? The point to be made here is that teachers in this study are intentionally oriented to their role as "guides" for the sake of creating conditions where students are empowered to *learn* rather than to be *taught*. In making such a conscious decision, they also opened themselves to being perceived as "not knowing the answers." However, therein lay their courage and strength is believing in themselves and in what they chose to build in the classroom.

Recent research (Goodyear & Dudley, 2015) on the role of the teacher as a learning facilitator suggests that the role of the facilitator is "synonymously associated with student-centered approaches" (p. 274). And as Goodyear and Dudley affirmed, "student-centeredness does not mean that students are simply left along by teachers" (p. 275). Instead,

> Student-centered approaches entail developing students' ability to become their own teachers and supporting them to know how to evaluate knowledge claims, how to learn, how to collaborate, how to seek help, how to become assessment capable, how to become resilient (particularly in the face of cognitive challenges) and aiding students to know what to do when they do not know what to do. (Goodyear & Dudley, 2015, p. 275)

Recommendation #5:

Include the theory, art, and practice of teachers as learning facilitators as an integral part of the teacher preparation curriculum within faculties of education and ongoing professional learning of in-service teachers.

Learning #3: Enabling Student Success by Building Competence and Confidence Cumulatively

When reforming the way that they taught, these six teacher research participants were always cognizant of the idea that mathematics is cumulative, and that Grade 9 Mathematics is just one part of a large continuum of skills**.** More specifically, all of these teachers approached learning mathematics from the perspective of building on what students *already know*, rather than focusing on what they don't know. Jack, for example, discussed how he had been asking himself "how do we dismantle units, and how do we bridge the connectivity between all of our math content as much as possible…?" In struggling with his question, Jack's method of teaching could be interpreted as being motivated by the desire to both dismantle and reconnect. When I use the word dismantle, I am referring to the concept of breaking down mathematics 'units' into a continuum of cumulative skills that build on each other with the purpose of showing students that there is a connection between different topics. Jack discussed how he viewed the importance of dismantling units when he said that "now I see it as pooling everything together and constantly reviewing things, and you're forcing students to build connections between content".

Dismantling and reconnecting, or bridging the connectivity, is a process of breaking away from thinking in terms of unit topics in isolation. For Jack, it was worth the struggle required by the process of creating conditions where students are able to see the connectivity between multiple math units rather than seeing each unit as distinct and separate from each other. His desire for connectivity is expressed in his discussion between him and Maria, in relation to creating cumulative exercises for their Grade 9 students. Jack expressed:

> The [learning of math] is cumulative; students are not just focused specifically on our course content... I think that there is a good attempt to make sure that learning from Grade 7 and Grade 8 is still relevant and being reviewed.

Jack was in fact putting into practice the potential of the Connection Standard as it is reflected in NCTM (2000). In that document we read that "instructional programs from prekindergarten through grade 12 should enable each and every student to

- Recognize and use connections among mathematical ideas
- Understand how mathematical ideas interconnect and build on one another to produce a coherent whole
- Recognize and apply mathematics in context outside mathematics"

As reflected in Chapter 5, this shift in focus to dismantling, connecting and building on what students already know in order to enable student success are reflected in the following practices. First, they provide students with big-picture activities with specified opportunities to wonder, inquire, represent, envision, and discuss. By drawing on students' contextualized experiences, these activities offer students opportunities to learn the big ideas of new content, before learning the details. Second, they organize their lessons in ways that provide 'grounding' or 'anchoring' activities at the beginning so that all students have an entry-point into the new learning. Finally, they provide students with opportunities to solve problems that are based in mathematics learning from previous years and then 'tack on' new information for them on a need-to-know basis. By organizing their teaching in these ways, these teachers are helping students realize that their new learning is actually grounded in and connected to things they already know, which thus helps build student confidence and competence in learning mathematics. This affirms that my teacher research participants are putting into practice one recommendation of the Manitoba mathematics curriculum (2014):

> When mathematical ideas are connected to each other or to real-world phenomena, students begin to view mathematics as useful, relevant, and integrated. Learning

> mathematics within contexts and making connections relevant to learners can validate past experiences and increase student willingness to participate and be actively engaged. The brain is constantly looking for and making connections. "Because the learner is constantly searching for connections on many levels, educators need to *orchestrate the experiences* from which learners extract understanding…Brain research establishes and confirms that multiple complex and concrete experiences are essential for meaningful learning and teaching" (p.9).

Recommendation #6:

That teachers continue to provide classroom experiences that support students' efforts to make connections between what they are learning with (a) materials and experiences that preceded their arrival into their respective classrooms, and with (b) mathematical ideas that they represent. While this process takes time, it includes both the teachers' expertise and the facilitation skills, and it is a process that is worth taking.

Learning #4: It Take a Village to Enable Student Success

All teacher research participants affirmed that they could not engage in the reform of their math classrooms without the support of their administration and their colleagues. For example, in my follow-up conversation with Jack and Maria, after I observed their classrooms, they shared that they have a principal who is very supportive of what they are trying to do in their classrooms. They explained that they were each given five days of release time; ten days in total; to work together on their programming specifically for Grade 9 Mathematics. In addition, their principal also provided other days of release time for their entire mathematics department in Grades 7-12 to work together to collaborate and plan.

In my conversations with Linda, she acknowledged the importance of a team approach with her colleagues in order to develop a program for her students. She referenced how important it was that one of the resource teachers at her school had developed a program and provided support for Grade 9 students who found mathematics especially difficult. This kind of support made Linda's job more manageable. As she expressed, "I would be in a lot worse off state mentally about work than I would be otherwise without the teamwork of our resource and math department… there is a lot of communication and it's awesome."

Dennis also discussed the importance of having support in his classroom when he explained that "the big thing is having that EA" (Educational Assistant) because the feedback provided by the EA offered him another opportunity to understand where his students were at in terms of their learning and what he needed to do for his next class. In all of these examples, as reflected in Chapter 5, teaching reform is further enhanced with (a) the support and encouragement of a teacher's administration through (i) constant dialogue and discussion (ii) financial support in order to implement programs, and (iii) release time to plan and co-plan with others, and (b) the support of and collaboration with teaching colleagues, learning support teachers, and educational assistants in order to collaborate about how to best help the range of diverse students in their class.

In summary, it would be fair to say that the level of support that is reflected in building a high-quality mathematics program in this research, is congruent with supportive efforts by both teachers and administrators to prepare students for "life-long learning" not only for the sake of "making connections between mathematical knowledge and skills and their applications," but also for the sake of "becoming mathematically literate citizens" (Manitoba mathematics curriculum, 2014, p.5).

Recommendation #7:

That the Education and Training department for the province of Manitoba, in partnership with faculties of education preparing future teachers, school superintendents, administrators, community leaders, and parents continue to prepare and support teachers and administrators to fulfill the principles and standards for school mathematics.

Learning #5: Enabling Student Success through Accountability and Co-Ownership of Learning

In reforming their mathematics teaching, I also learned that these teacher research participants were also promoting student autonomy, ownership, and co-ownership of their learning, as well as encouraging a sense of responsibility for the learning of their peers. As Jack and Maria described their reformed teaching methodologies, they continued to acknowledge how using methods such as solving problems in groups on vertical surfaces encourages a sense of ownership and co-ownership among their students. As Jack explained:

> There has always been this 'math thing' that you're supposed to get through this curriculum, or math is being 'done to me' and now it just seems like there's this sense of ownership (among the students) because we're not having to force them to learn in the same way anymore; it's a socially engaging activity.

We notice here the transforming power of their reformed teaching methodology. Their students are now seen as not experiencing math as something that is being done *to* them, but rather as a socially engaging activity. In this new activity, students are active in both their own learning and in the learning of their peers. There is a transformation from "knowing" mathematics in the sense of getting through the curriculum, to "owning" the learning of mathematics. As Jack affirmed, students in their reformed teaching classroom do not portray

their experience as "being forced to learn." In being engaged in the activity of "doing math" differently, they are subtly transformed into being engaged learners.

In my conversations with Linda, she described another teaching method that she used to promote student ownership and responsibility. She explained that she was trying to spend more time helping students improve their affective domain of learning. She described this process as "talking to the kids and setting goals together. We go through the outcomes and I ask them 'how did you study? What did you do to prepare? What can we do differently?" She acknowledged that she has received some pushback from teachers who say "this is taking time out of my teaching" and "(setting goals) is not part of teaching my curriculum." However, she asserted that the "definition of insanity is doing the same thing over and over again and expecting different results. So that's why I talk to the kids and we set goals." And, as Lucia also surmised, "when you empower kids to be autonomous, they just start taking it [their learning] into their own hands. They start making decisions that are best for their learning". The Manitoba mathematics curriculum (2014) supports this notion:

> Teachers, students, and parents need to recognize the relationship between the affective and cognitive domains and to nurture those aspects of the affective domain that contribute to positive attitudes. To experience success, students must be taught to set achievable goals and assess themselves as they work toward these goals. Striving toward success and becoming autonomous and responsible learners are ongoing, reflective processes that involve revisiting the setting and assessing of personal goals (p.5).

The examples above and those described in Chapter 5 illustrate how these teacher research participants value both (a) student accountability for their own learning, including

reflecting on their affective behaviors that affect learning, and (b) the importance of taking responsibility for each other's learning within their classroom community.

Recommendation #8:

That teachers continue to generate conditions where students are able to take responsibility and ownership of their own learning and the learning of their peers. A means of doing this is by asking reflective questions and engaging students in problem-solving activities rather than providing immediate answers and engaging them in individual work activities.

Conclusion

At the beginning of this research project I sought to gain a deeper understanding of the role of teachers in enabling success for all students in Grade 9 Mathematics education. Through completing my research, I have come to realize that what is in common among all of these teachers is that they are all on a continuum, moving towards a new way of teaching and away from the benchmark of traditional teacher-centered instruction. However, what is unique to each individual teacher's experience in this group of research participants is their distinct classroom or school situation, and mandates in which they are operating. In my quest for "meaning-making" from this pool of teachers, I realize that their individual positionings on the continuum of teaching reform in Grade 9 Mathematics is affected by their unique contexts, purposeful intent (what they are aiming to achieve), their personal pedagogy, philosophy, and teaching values.

I believe that all of these teachers have made the decisions they've made to reform their teaching practices because they are all trying to achieve a higher purpose in their classrooms. For example, while at first glance, something like working with other students on whiteboards may look like a small and trivial change, there is a higher purpose that these teachers are trying to achieve in setting their classroom up in this way. I interpret this higher purpose as finding a

balance between (a) enabling conditions where students become autonomous, responsible, and critical participants in their own learning, and (b) building a classroom community where students are encouraged to collaborate, communicate, and take co-ownership for the learning of their peers and therefore are engaged in a sense of social responsibility. As I noted in the Introduction to this chapter, this can be summed up as promoting classroom citizenship among their students: citizenship as individuals, who are accountable and take ownership for their own learning and understanding, and citizenship as members of the classroom community; students who are engaged in social responsibility and social equity amongst their peers. Is this not a goal of the NCTM, called "Productive Disposition" where students are empowered to (a) appreciate and value mathematics, (b) value and commit themselves to life-long learning, and (c) become mathematically literate citizens?

In Chapter One of this research study, I limited my scope to include teachers who are in situations where structural changes were implemented to provide them with more time to teach the Grade 9 Mathematics course. I began with the assumption that only teachers who had extra time to teach the course had the capacity to implement new methods of teaching and learning. However, while the teachers in this study used the extra time to reform their teaching methods to better enable student success, I believe that their creativity and commitment towards the reformation of their curriculum is not dependent upon this (extra time) as a critical factor. In fact, the essence of all of these teacher's experiences is their willingness to participate in several substantial changes to their teaching role and practice. First, they are willing to change their role as a facilitator of learning. Second, they have the courage to engage students in productive struggles. Finally, they are creating conditions in their classrooms that encourage students to be collaborative, communicative, and responsible members of a mathematics learning community.

Chapter 7 Final Questions & Reflections

Teachers as Learners

Recently I came across a quote attributed to the famous Italian artist and intellect Michelangelo, who said "*Ancora imparo*" which loosely translates into English as "I am still learning." He said it when he was 87 years old while working on the art in St. Peter's Basilica in Rome, Italy. As I reflect on what I have learned from completing this personal research project, I cannot help but wonder about why these six teachers have chosen to take full advantage of their teaching opportunities to change their practice, while other teachers seem to have similar opportunities to move out of their comfort zones but choose not to. What makes these teachers, regardless of their age or point in their career, willing to 'still learn?'

I have come to realize that the teacher research participants I had the honor of learning from are not just *teachers*, but in fact they themselves are life-long *learners*. They are all willing to learn something new or think differently about an aspect of their practice. They are all willing to improve something they already do, or make changes to their practice. As teachers, we have the unfortunate choice of becoming what Dweck (2016) describes as "fixed-mindset teachers, (who) often think of themselves as finished products. Their role is simply to impart their knowledge" (p.204). In her book *Mindset: The New Psychology of Success*, Dweck describes one of her professors when she was in graduate school. She describes him as a wonderful educator who told her to always question assumptions. She quotes him in her book as saying "there's an assumption that schools are for students' learning. Well, why aren't they just as much for teachers' learning?" (Dweck, 2016, p.204). Dweck describes how she "never forgot that. In all of my teaching, I think about what *I* find fascinating and what *I* would love to learn more about. I

use my teaching to grow, and that makes me, even after all these years, a fresh and eager teacher" (p.204).

Through completing this research project, I have realized that, in order for any positive change or reform to take place in our education system, it begins with the growth mindset of teachers such as those described in this study. These are teachers who are willing to learn, grow, and change their perspective and practice. They are teachers who are willing to collaborate with other professionals and learn from them in order to better themselves as teachers. They do not think of themselves as a 'finished product', but rather as life-long learners who always have room for improvement. They are not only interested in teaching, but they are also interested in *learning*.

Where do I fit?

As I noted in Chapter 1, my fundamental concern as a Grade 9 Mathematics teacher is to prepare *all* students within this course <u>well</u> for *all* pathways of mathematics in Manitoba. This is why this research project has also been a very personal endeavour for me; I sought to learn from my colleagues about what I can personally do to enable *all* students to be successful in learning mathematics.

As I complete this research project, I am reflecting on what 'student success' really is, and what I am doing to enable this success in my own Grade 9 Mathematics classroom. While this project has come to an end, in that I am now "finished," my learning continues. I have come to realize that student success is not only defined by the achievement of curricular content, nor should this be the entire focus of mathematics education. I've come to realize that my definition of student success is more about building students' confidence, not only in their competence in mathematics, but perhaps more importantly, as growing young adults. Student success for me is

increasing students' willingness to communicate and collaborate with each other in a respectful and inclusive way. Student success for me is watching them take learning risks with each other and asking meaningful questions of each other when they get stuck. I've come to realize that I care about both preparing students in terms of understanding mathematics curricular outcomes, *and* for preparing students to be respectful, collaborative, questioning, reflective adolescents.

After working through my thesis, I feel like I have gained perspective and have grown as an educator and as a scholar. I hope that what I have offered and discussed will be of some help to other teachers who are curious about learning how to enable success in their mathematics classroom. However, they might have to redefine what success looks like first. Either way, if teachers are willing to take the first step and willing to 'still learn' what it means to create conditions for student success, I think our students are in good hands.

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APPENDIX A

Sample copy of consent form for teacher research participants

Research Project Title: Grade 9 Mathematics in Manitoba: Reforming the way we teach

Principal Investigator:
Sacha Amaladas
Mathematics Teacher
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Winnipeg, MB, Canada
R#N #G#
Tel. (204)###-####
Email: umamalas@myumanitoba.ca

Winnipeg, [Date]

Dear Mr(s). [NAME],

I am a Master's of Education student in the department of Curriculum, Learning and Teaching at the University of Manitoba and the principal investigator in a research project that explores the teaching methodologies and practices of Grade 9 Mathematics teachers and the motivation and rationale behind the teachers' decisions and choices. I would like to request your consent for participation in this research project and to collect data from you.

This consent form, a copy of which will be left with you for your records and reference, is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, you should feel free to ask. Please take the time to read this carefully and to understand any accompanying information.

The purpose of this research project is to investigate the experiences of Grade 9 Mathematics teachers and gain an in-depth understanding of their role in enabling student success. This will provide insight into the different teaching methodologies and strategies that might be used in Grade 9 Mathematics classrooms to better create conditions for student success. The central question that will frame my research is: what are the underlying features of the experiences of Grade 9 Mathematics teachers in Manitoba who are trying to reform Grade 9 Mathematics education?

The data collection for this project will take place on through interviews, classroom observations, and follow-up interviews. Both sets of interviews will take place on pre-specified days and times, arranged with each individual participating teacher. The classroom observation

the Grade 9 Mathematics class will take place on pre-specified days and times, arranged with teach individual participating teacher.

I will use a small digital audio voice recorder to record the teacher during both interviews. I will not audio or visual record anything during the classroom observations; I will only be taking notes.

Special care will be taken to guarantee the confidentiality of the data collected as part of this study. I will be the only person with access to raw audio data, and I will ensure that all identifiers (such as your name and the name of your school) will be omitted or replaced by pseudonyms. Any data will be securely stored in password-protected hard drives or in locked drawers in my house, and only I will have access to it. All data will be destroyed after five years from the conclusion of the projected, estimated to happen in October 2019.

If you indicate that you would like to revise materials produced for dissemination of this research (by signing in the appropriate field below), I will send you any dissemination material for you to review. You will have at least two weeks to provide feedback on these materials; if you find that you do not want your data included in these materials, I will remove this data from these materials.

Participation in this research project is completely voluntary, and you may withdraw from participating at any time, even after having signed the consent form, with no prejudice or consequence. No risks or harms to the participants are foreseeable as a result of participation in this research project. No compensation will be provided to participants. There are no direct benefits to participants, but they may be interested in learning more about this topic through the opportunity to review pre-print and summaries of dissemination materials.

Your signature on this form indicates that you have understood to your satisfaction the information regarding participation in the research project and agree to participation as a subject. In no way does this waive your legal rights nor release the researcher from their legal and professional responsibilities. You are free to withdraw from participation in this study at any time, without prejudice or consequence. Your continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout your participation.

The University of Manitoba may look at your research records to see that the research is being done in a safe and proper way.

This research has been approved by the Nursing and Education Research Ethics Committee. If you have any concerns or complaints about this project you may contact the principal investigator (information provided above) or Dr. Zana Lutfiyya; the Chair of the Research and Ethics Board at the University of Manitoba, by phone at (204)474-8714 or by email at zana.lutfiyya@umanitoba.ca.

A copy of this consent form has been given to you to keep for your records and reference.

[Signature] [Date]

Sacha Amaladas

_____

[Participant's Full Name – in print]

_____ _____

[Participant's Signature] [Date]

I would like to receive pre-prints and final drafts of dissemination materials or their summaries by:

- Email at: _____

- Regular mail at the following address:

_____

_____

_____

_____ _____

[Participant's Signature] [Date]